**MLA 6-92**

Mineral Land Assessment
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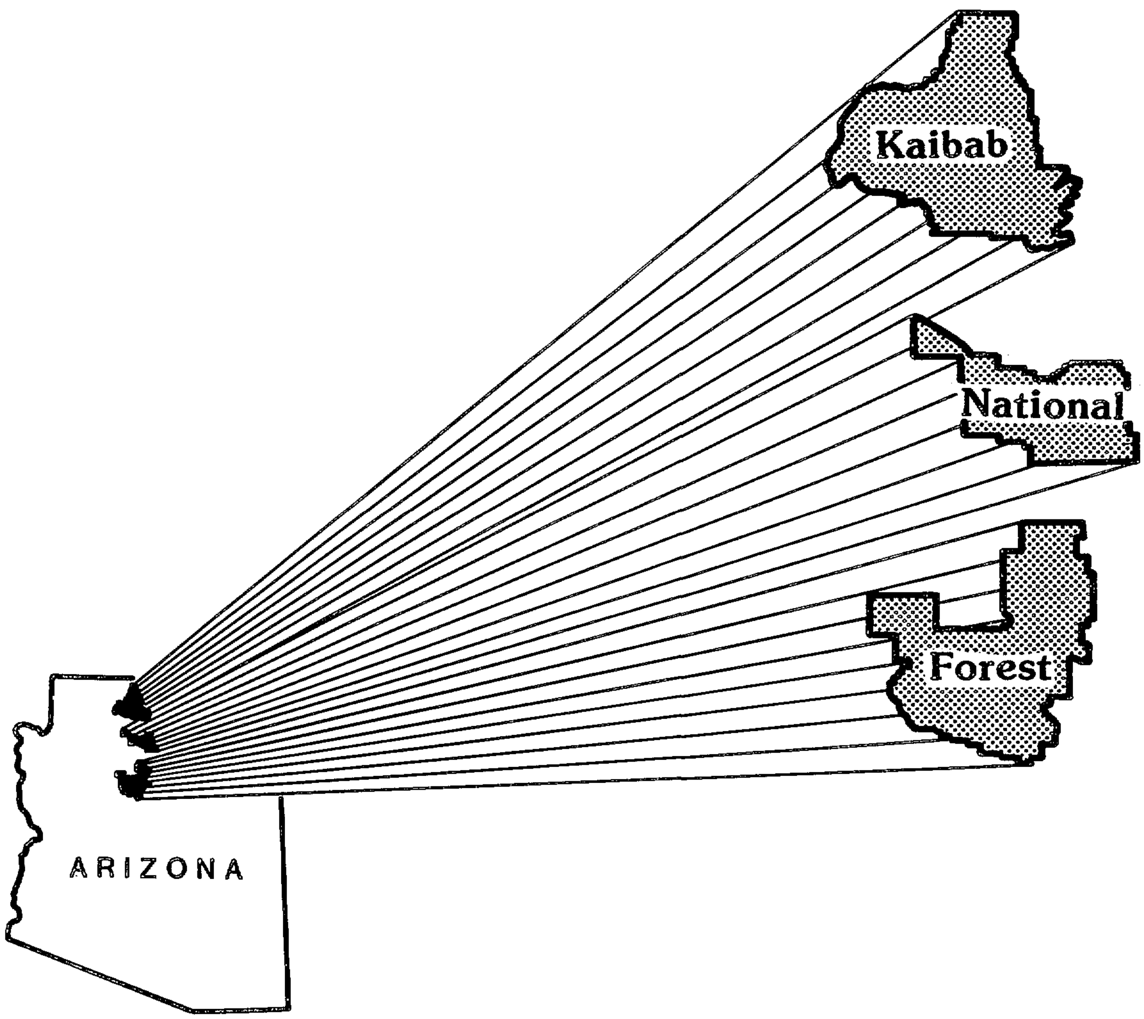
# Mineral Appraisal of the Kaibab National Forest, Arizona




BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR

# MINERAL APPRAISAL OF THE KAIBAB NATIONAL FOREST, ARIZONA

by

David C. Scott

MLA 6-92
1992

Intermountain Field Operations Center
Denver, Colorado

UNITED STATES DEPARTMENT OF THE INTERIOR
Manuel Lujan Jr., Secretary

BUREAU OF MINES
T S ARY, Director

PREFACE

A January, 1987 Interagency Agreement between the Bureau of Mines, U.S. Geological Survey, and U.S. Forest Service describes the purpose, authority, and program operation for the forest-wide studies. The program is intended to assist the Forest Service in incorporating mineral resource data in forest plans as specified by the National Forest Management Act (1976) and Title 36, Chapter 2, Part 219, Code of Federal Regulations, and to augment the Bureau's mineral resource data base so that it can analyze and make available minerals information as required by the National Materials and Minerals Policy, Research and Development Act (1980). This report is based on available data from literature and field investigations.

This open-file report summarizes the results of a Bureau of Mines forest-wide study. The report is preliminary and has not been edited or reviewed for conformity with the Bureau of Mines editorial standards. This study was conducted by personnel from the Resource Evaluation Branch, Intermountain Field Operations Center, P.O Box 25086, Denver, CO 80225.

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## ABSTRACT

Copper, lead, silver and gold have been mined from limestone-hosted, strata-bound deposits in the North Kaibab and Tusayan Ranger Districts. In addition to these metallic deposits, volcanic cinders, pumice, flagstone, and sand and gravel have been quarried in the Chalendar and Williams Ranger Districts. Basalt is present in unlimited quantities in the Williams and Chalendar Ranger Districts and could be used for road fill and construction material.

Uranium-mineralized breccia pipes are known to occur throughout the region of the North Kaibab and Tusayan Ranger Districts. These pipes commonly have a circular topographic expression. Petroleum Information Corporation and the Bureau performed an aerial photography interpretation to identify circular features in these two districts. This information can be used to guide field work to determine if these circular features may be caused by breccia pipe structures.

By previous exploration, at least ten uranium-mineralized breccia pipes have been identified in the Tusayan Ranger District. One of these, the Canyon pipe, contains a high-grade uranium ore body with associated silver, copper, lead, vanadium, and zinc. The mine permit for the Canyon pipe has been approved, and the mine shaft head frame constructed.

## INTRODUCTION

To assist the Forest Service land-use planning effort, the Bureau of Mines appraised mineral resources in the Kaibab National Forest, Coconino County, northern Arizona. Field investigations by the Bureau of Mines were conducted in 1990 and a report was prepared in 1991. The Forest is administered by the U. S. Department of Agriculture, Forest Service. The Kaibab National Forest encompasses approximately 1.6 million acres in four separate ranger districts. The presentation of mineral data in this report is grouped according to commodity with a separate section on breccia pipes. For each commodity, mineral occurrences of that commodity were evaluated for the entire Forest.

### Geographic setting

The Kaibab National Forest in Coconino County, northern Arizona, comprises four ranger districts (fig. 1). The Williams and Chalendar Districts, adjacent to each other, are just west of Flagstaff, Arizona, along Interstate 40; Williams, Arizona, lies between the two districts. Acreage in the Williams District totals 303,299 acres, while the Chalendar District contains 270,552 acres. Both districts can be accessed from Interstate 40, west of Flagstaff. The 325,026-acre Tusayan District is about 10 mi north of the Williams and Chalendar Districts and is adjacent to the southern boundary of Grand Canyon National Park. Tusayan, Arizona, is in the northwestern part of the district; access to the district is from State Highway 64, north of Williams. The 655,910-acre North Kaibab District is about 20 mi north of the Tusayan District

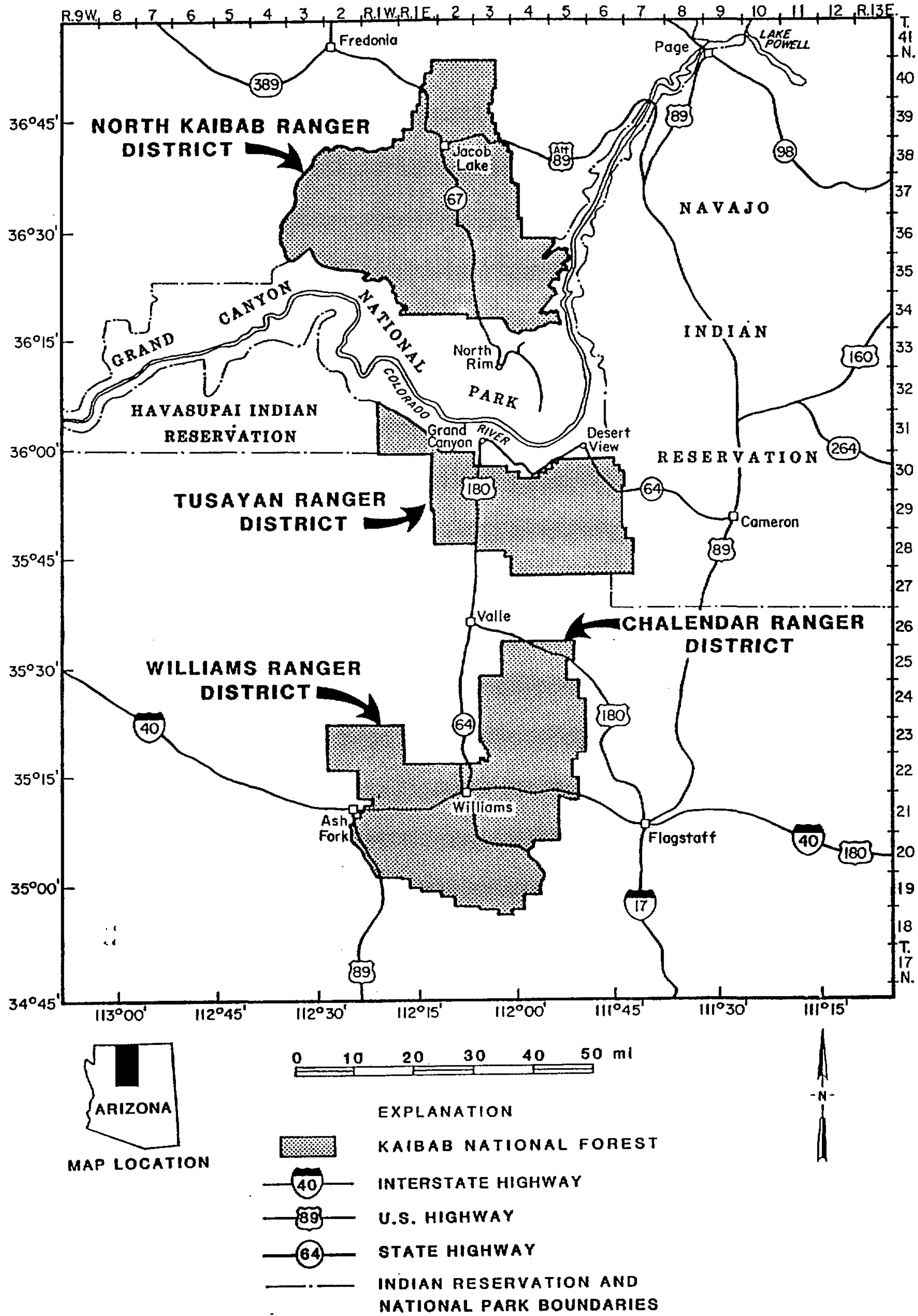



Figure 1. Index map of the Kaibab National Forest, Coconino County, Arizona.

and adjacent to the northern boundary of Grand Canyon National Park. Access to the area is from either U.S. Highway Alternate 89 from Fredonia, Arizona, on the northwest, or from Marble Canyon, Arizona, on the east. Jacob Lake is in the north-central part of the district. County roads and Forest Service logging roads provide access to the interior of all four districts.

The Kaibab National Forest is in the Colorado Plateau Physiographic Province and includes all or parts of the Bill Williams Mountain, Kendrick Peak, Kanab Creek, Saddle Mountain, and Sycamore Canyon Wilderness areas. Prominent topographic features are the Kaibab and Coconino Plateaus and the Coconino Rim. Topography in the Forest varies from tree-covered cinder cones in the Williams and Chalendar Ranger Districts, to relatively flat terrain accentuated with broad washes cutting the Coconino Plateau in the Tusayan Ranger District, to heavily-forested, steeper canyons cutting the Kaibab Plateau in the North Kaibab Ranger District. Elevations in the Forest range from a low of 5,500 ft in the Williams District to 10,418 ft on Kendrick Mountain in the Chalendar District.

## Previous investigations

A significant amount of literature is available dealing with the geology, mining, and mineral resources of the Kaibab National Forest. Wilderness reports prepared by the Bureau of Mines and the U.S. Geological Survey are the source for information on the wilderness areas.

One of the most comprehensive and current bibliographies of references available was prepared by Van Gosen (1989). The report, a proposed research project for a Masters Degree at the Colorado School of Mines, contains references on base and precious metals, mining history and production, and uranium deposits in the region of the Forest.

Currently, George Billingsley of the U.S. Geological Survey is writing a report on the history of mining in the Grand Canyon area, which includes parts of the Kaibab National Forest.

## Methods of investigation

A comprehensive literature search for pertinent geologic and mining information was conducted prior to the field examination. Existing mineral resource data were used to characterize and further delineate known metallic mineral deposits and saleable mineral commodity deposits. Bureau of Land Management records were examined for location of patented and unpatented mining claims, oil and gas leases, and coal leases. A total of 1,845 unpatented mining claims were on file as of February, 1991. This includes claims that may be abandoned, but that are not yet recorded as such. The Forest Service provided data on saleable commodities within the Forest. In 1990, a field investigation was performed throughout the forest to examine mines, prospects, claims, and mineralized areas.

A total of 65 man-days were spent conducting a field investigation. Accessible mine workings were surveyed by the compass-and-tape method and sampled. One hundred and fourteen rock samples were taken and analyzed for various metals; three of those samples were re-analyzed to verify gold concentrations detected. All samples were analyzed by direct irradiation-instrumental neutron activation for a suite of 33 elements and by fire assay/atomic absorption spectroscopy for gold. The 33-element assay was performed by Bondar-Clegg Labs., Lakewood, CO. All samples were analyzed for gold by fire assay/atomic absorption spectroscopy by Bondar-Clegg, Lakewood, CO; some samples were reanalyzed by Chemex Labs., Sparks, Nevada. (See table 2).

The Bureau of Mines conducted a study to identify circular features, that can be spotted from the air and air photography, which may indicate buried breccia pipes, possibly containing uranium, in the Tusayan Ranger District. This study is discussed in detail in a section entitled "Breccia Pipes" in this report.

Several samples of cinder from throughout the Forest were collected and analyzed for gold. Outcrops of flagstone, used in the building industry, were inspected to compare both color and texture to flagstone currently being sold from the forest.

## Acknowledgements

Bureau of Mines employee Carl Almquist assisted in the field and report preparation. The U.S. Geological Survey assisted in some of the initial aerial photography interpretation and some field work in the Tusayan Ranger District. U.S. Forest Service personnel in Tusayan, Phoenix, Williams, and Albuquerque, contributed valuable data to this report.

## Geologic setting

The North Kaibab and Tusayan Ranger Districts are geologically similar and therefore will be discussed concurrently. Although rocks in the North Kaibab and Tusayan Districts range from Permian to Triassic in age, the Permian-age Kaibab Limestone is the predominant geologic unit present in both areas. The Kaibab Limestone is divided into the Harrisburg Gypsiferous and Fossil Mountain Members. Within the North Kaibab and Tusayan Districts, more than 90 percent of the surface area is Harrisburg Gypsiferous Member; the remaining percentage is covered by the Fossil Mountain Member and other sedimentary rocks of Permian and Pennsylvanian-age. In both districts, where erosion has removed the overlying Harrisburg Gypsiferous Member, the Fossil Mountain Member of the Kaibab Limestone is exposed (Moore and others, 1960).

The Harrisburg Gypsiferous Member consists of thinly bedded limestone, shale, and gypsiferous siltstone; the Fossil Mountain Member consists of fossiliferous cherty limestone. At the Grand Canyon, the Kaibab Limestone is 400 to 510 ft thick; at the Canyon pipe in the Tusayan District, the limestone is about 600 ft thick (Moore and others, 1960).

Structurally the North Kaibab and Tusayan Ranger Districts are rather simple. One major fault, the 7-mile-long West Kaibab fault, which separates the Kaibab Plateau from the Kanab Plateau, trends roughly north-south, inside the western boundary of the North Kaibab District. The fault is believed to be related to underlying Precambrian zone weaknesses. In the North Kaibab and Tusayan

Districts, numerous smaller scale, north-northwest to north-northeast-trending faults are present (Moore and others, 1960).

Unique to the northern Arizona plateau region, including the Kaibab and Coconino Plateaus in the Kaibab National Forest, are breccia pipes. A detailed description of breccia pipe geology and development is presented in a separate section of this report.

Geology in the Williams and Chalendar Ranger Districts is similar and therefore will be discussed concurrently. Approximately 85 to 90 percent of the districts are underlain by Miocene-age to Holocene-age volcanic rocks. Most of the volcanic rocks are basaltic flows; however, numerous cinder cones composed of scoriaceous material are present in the Chalendar District. Some cinder and a small amount of pumice are present in the Williams District. The Permian-age Coconino Sandstone crops out over about ten to fifteen percent of the Williams District, mostly in the extreme southern and northern parts (Moore and others, 1960).

## Mining districts and history

The earliest recorded mining activity in the Kaibab National Forest took place about 1890 when copper was discovered near Tusayan, in the Tusayan Ranger District. The Francis mining district was established in about 1907, 4-5 mi southwest of the community of Tusayan. The mining district is about 8-10 mi long and about 2-3 mi wide (pl. 1).

Copper occurrences in the mining district situate along a linear trend, from north to south; however, no controlling structures have been mapped in this immediate vicinity. The copper mineralization consists of secondary copper minerals including azurite, chrysocolla, and malachite in siliceous, brecciated horizons of the Kaibab Limestone. These minerals commonly coat fracture surfaces and bedding planes within chert breccias, sandstones, and silicified limestones. The breccia zones are 10 to 40 in. thick and many cover an area of over 100 $ft^2$. Complete production figures for all years for the district are not available; however, between 1901 and 1970, 730,000 lbs copper, 500 lbs lead, 100 oz gold, and 4,000 oz silver were produced (Keith and others, 1983, p. 26-27).

The Warm Springs mining district is in the North Kaibab Ranger District. The district encompasses an area about 5 mi long and about 1-2 mi wide (pl. 1). Copper occurrences in the district are similar to those in the Francis mining district and are considered to be stratabound and spatially related to siliceous, brecciated horizons of the Kaibab Limestone. Although the copper oxide-stained breccia zones are usually 10 to 20 in. thick, some zones may be up to 60 in. thick and may cover an area 10 to 50 ft wide and 50 to 500 ft long. The oxide copper minerals azurite, chrysocolla, and malachite coat fracture surfaces and bedding planes within the brecciated zone. Complete production figures are not available for the Warm Springs district, however, between 1903 and 1963, 4,252 lbs copper, 2,000 lbs lead, 200 oz gold, and 17,000 oz silver were produced from 33,000 tons of ore (Keith and others, 1983, p. 52-53).

Although the Grandview mining district is not in the Kaibab National Forest, the proximity and geological similarity to the Warm Springs mineral occurrences make it necessary to present a brief discussion.

The Grandview district is between the Tusayan and North Kaibab Ranger Districts. The mining district includes one mine, the Grandview (Last Chance claim), which is on Horseshoe Mesa in Grand Canyon (pl. 1). The mine is within the Grand Canyon National Park; therefore, access to the mine is by foot trail only.

The first assessment work on the claim was recorded in 1890 and between 1901 and 1964, 936,000 lbs copper and 14,000 oz silver were produced from 2,200 tons of ore (Keith and others, 1983, p. 28-29).

The Grandview Mine is on a brecciated monoclinal flexure in the Redwall Limestone. The most abundant minerals present are sulfates such as: cyanotrichite, brochantite, chalcoalumite, langite, barite, devilline, chalcanthite, antlerite, and gypsum. Carbonates are also present, notably aurichalcite, azurite, malachite, and smithsonite. Arsenates include metazeunerite, zeunerite, scorodite, olivenite, and adamite. Other minerals present in small amounts include hemimorphite, kaolinite, illite, and pyrite. (See Billingsley, 1974, p. 174.)

In the early 1900's, Emmons evaluated the mineral deposit and noted some interesting facts. Copper mineralization was absent in rock formations older or stratigraphically below the Redwall Limestone. This lead him to believe that mineralization was not from ascending fluids or an igneous source. Emmons further theorized that the copper ores were formed by the leaching down of copper from deposits in the Triassic strata that originally covered them. (See Emmons and Hayes, 1904, p. 221.)

The Orphan mining district is outside the northwest boundary of the Tusayan Ranger District and consists of only one mine. The Orphan copper deposit was discovered in 1893, a few thousand feet below Maricopa Point, in the Grand Canyon. Like all of the other copper mines in the Grand Canyon, the Orphan was not particularly profitable and was inactive for many years. In 1951, the U.S. Geological Survey determined that the deposit was very rich in uranium. The ore body occurs in and adjacent to a breccia pipe which terminates near the base of the Redwall Limestone--a vertical range of about 2,000 ft. There were over sixty different minerals taken from the Orphan Mine. The ores contained antimony, arsenic, cobalt, copper, gold, iron, lead, magnesium, manganese, molybdenum, nickel, mercury, selenium, uranium, vanadium, and zinc. (See Billingsley, 1974, p. 176.)

Between 1951 and 1961, 4,534,000 lbs copper, 7,000 lbs lead, 600 lbs zinc, and 80,000 oz silver were produced from 12,000 tons of ore. From 1961 to 1969 4,360,000 lbs of uranium and 509,025 long tons of manganese were produced. (See Keith and others, 1983, p. 40-41.)

## Current mining activity

The most recent mining activity in the Kaibab National Forest includes mining of sandstone for building stone, cinder for construction use, and sand and gravel for construction use. Copper has been mined in past years and exploration for uranium is ongoing.

Several mining companies currently maintain interests in uranium-mineralized breccia pipes. Activity, which includes mining, claim staking, and assessment work, exploration, and in some cases, drilling, is discussed in the breccia pipe section of this report. Most significantly, Energy Fuels Nuclear has been issued a mine permit for the Canyon pipe and has constructed a headframe at the site, which is about 7 mi southeast of the town of Tusayan, Arizona, in the Tusayan District.

Copper mining activity in the Warm Springs and Francis mining districts has been nonexistent for many years. Mining claims continue to be filed in the Tusayan Ranger District. As of February 1991, 1,845 unpatented claims and four patented claims were on file with the BLM.

Cinder is the primary mineral commodity of interest in the Chalendar Ranger District. The Forest Service sells it by volume from pits scattered throughout the district.

In the Williams Ranger District, Coconino Sandstone is sold by the Forest Service for use as building stone. Two areas currently have production: north of the town of Ash Fork, and the Drake area, in the southwestern part of the ranger district. This commodity is purchased by weight from the Forest Service and most of it is processed (split, cut, sorted, and stock piled) in the Ash Fork area.

There has been recent interest in pumice occurrences on the east flank of Bill Williams Mountain in the Williams Ranger District. Although pumice has a number of applications, a recently developed use is as an abrasive in the garment finishing industry to produce stone- and acid-washed denim fabric.

Limestone, which is present throughout most of the North Kaibab and Tusayan Ranger Districts, is quarried and crushed as needed for use in road construction. Its value is limited by transportation costs to local use.

Local interest in sand and gravel is long-standing. Although cinder is more commonly used in road construction, sand and gravel has significant demand in areas where construction projects are underway. Stream beds are the only source for this commodity.

## APPRAISAL OF COMMODITIES

The location and characteristics of each mineral commodity in the Kaibab National Forest are discussed individually. Uranium occurrences are associated with breccia pipes in the Tusayan and North Kaibab Ranger Districts. Cinder and pumice are found in the Williams and Chalendar Ranger Districts and flagstone is found in the Williams District. Sand and gravel is found in stream channels throughout the Forest. Base- and precious-metal occurrences, associated with intraformational breccias in the Kaibab Limestone, are known only in the Tusayan and North Kaibab Districts.

### Base and precious metals

Copper is the predominant base metal of commercial interest in the Kaibab National Forest. Other base metals are associated with the copper; however, none have been mined exclusively. Gold and silver are also associated with the copper and have been extracted in copper processing.

The origin of copper mineralization in this area is not fully understood. One theory is that there is a genetic relationship between the stratabound copper deposits and faults, but no genetic association has been documented. Fracturing within the copper mineralized zones and the concentration of mineral deposits on the fracture surfaces was the evidence used to suggest that deposition of the copper minerals may have been fault controlled. However, fault zones are not currently known in the area of the copper mineralization. A second theory is that there is a possible genetic relationship between the copper mineralization that occurred in the stratabound deposits and the copper mineralization in the breccia pipes. A third theory suggests descending waters transported the copper from the overlying red beds of the Moenkopi Formation into the receptive intraformational breccia zones, where the copper was then deposited. (See Van Gosen, 1989, p.8.)

Tourtelot and Vine (1976, p. C27) proposed that the copper deposits resulted from supergene processes some distance from a primary deposit that has since been completely destroyed by continued erosion. The authors further state that the deposits are seemingly formed as static bodies localized by zones of intense reduction in a generally reducing environment. This could explain why more copper deposits are not found throughout the Kaibab Limestone in this area.

Both the Warm Springs (Jacob Lake) and Francis mining districts had copper, gold, and silver production. The Warm Springs district will be discussed first.

Warm Springs (Jacob Lake) mining district

The Warm Springs mining district, in the North Kaibab Ranger District, is 1-2 mi west of the village of Jacob Lake, Arizona (pl. 1). The original workings were situated on 20 patented and 15-20 unpatented claims (Tainter, 1947, p. 4). From about 1902 to 1947, the claims changed ownership several times. Since 1906, nearly all of the North Kaibab District has been withdrawn from new mineral entry as a result of the creation of the Grand Canyon National Game Refuge. Therefore, no claims are on file with the BLM for most of the acreage in the North Kaibab District.

Rocks in the Warm Springs mining district are calcareous sandstone, cherty limestone, and chert of the gently dipping, Kaibab Limestone, underlain by the Toroweap Formation, Coconino Sandstone, Hermit Shale, and Supai Formations. The Kaibab Limestone is up to 600 ft thick in some areas. Copper minerals are stratabound within siliceous intraformational breccia horizons of the limestone. Azurite, chrysocolla, and malachite coat fracture surfaces and bedding planes in silicified limestone, cherty breccia fragments and cherty arenaceous sandstone. The siliceous, cherty, mineralized rocks appear to be limited to one horizon within the Kaibab Limestone. The copper mineralization is within a few feet of the present erosional topographic surface. No copper deposits are found in more deeply incised areas, such as canyons.

The overall shape of the deposits is lenticular within the limestone breccia. At the mine workings, the breccias are from 0.5 to 8.5 ft thick. In some outcrops, copper carbonates are present at the surface, but can extend to a depth of 30 ft below the surface. Twenty-five rock-chip samples (nos. 1-25) were taken from the workings in the area; copper concentrations range from 0.18 to 7.26% (fig. 2, tables 2 and 3). Gold concentrations range from less than 5 ppb to 7 ppb and silver concentrations range from less than 5 to 14 ppm. Elevated concentrations of arsenic, cobalt, nickel, molybdenum, tin, and zinc are also present in these samples.

Although some select samples in the district contained significant concentrations of copper, the relatively thin beds containing the copper mineralization constitute too small a tonnage to make the deposit desirable for future development.

## Francis mining district

Five small areas of workings comprise the Francis mining district (pl. 1). These areas are found along a generally north-south, 14-mi-long trend in the Tusayan Ranger District. No geologic structure is evident along the trend.

Rocks in the Francis mining district are calcareous sandstone, cherty limestone, and chert of the gently dipping, Kaibab Limestone, underlain by the Toroweap Formation, Coconino Sandstone,

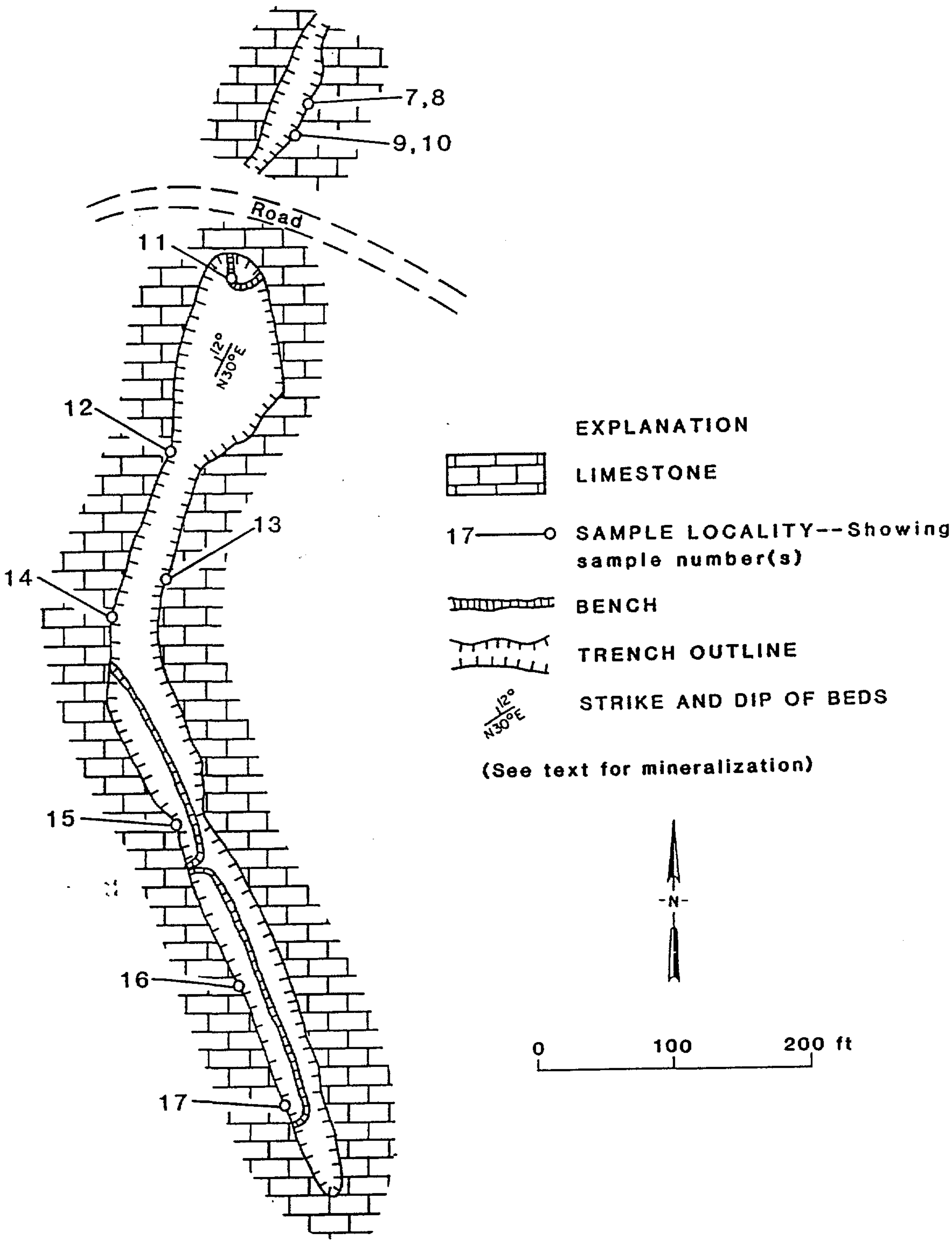



Figure 2. Map of the largest working in the Warm Springs mining district showing sample localities 7-17.

Hermit Shale, and Supai Formations. The Kaibab Limestone is probably between 500 and 600 ft thick. Copper mineralization is similar to mineralization in the Warm Springs district. The oxide copper minerals azurite, chrysocolla, and malachite coat fracture surfaces and bedding planes in a silicified intraformational breccia horizon of the limestone. The mineralized horizon is within a few feet of the present surface.

Although some samples from the Francis mining district contain significant concentrations of copper, the samples were taken across a narrow horizon of the limestone; therefore, deposits would contain only small tonnages of mineralized rock.

### Northern area

Workings in the northern part of the Francis mining district are on two patented mining claims, surrounded by Kaibab National Forest. The northern claim is owned by Eric and Susan Hovey, Grand Canyon, Arizona; the southern claim is owned by Red Mountain Mining Inc., Mesa, Arizona. No production data or history are available for either claim.

Copper minerals are concentrated along a narrow horizon that is up to 30 inches thick. Sample sites 28-29 are from trenches excavated to a depth of 8 ft (pl. 1). Sample site 27 has been reclaimed and only small pieces of malachite-stained limestone remain on the ground surface. One select grab and two rock-chip samples were taken from the reclaimed area and two trenches respectively (table 1). Copper concentrations range from 2.71 to 7.36% (table 2). The select grab sample had the highest concentration of copper. Gold concentrations range from less than 5 ppb to 7 ppb and silver ranged from less than 5 ppm to 17 ppm. Elevated concentrations of arsenic were present in the samples. The deposits are very small, probably less than 500 st of copper-bearing or mineralized limestone at each occurrence.

### Coconino Wash area

A small group of prospects was found just south of Coconino Wash about 2 mi south of the northern area just described. None of the prospects is large enough to have had much tonnage of material removed. Six samples were taken in the area of about a dozen pits scattered over a 1 sq mi area (pl. 1, fig. 3, sample nos. 30-35). Copper concentrations range up to 2.83%; gold and silver concentrations are below detection limits in all samples except no. 66 where gold was 16 ppb and silver was 9 ppm (table 2). Elevated concentrations of molybdenum were found in two of the samples (nos. 30 and 35).

### Eastern Star Mine (Southern Star)

Ten to twelve prospects and trenches and one 145-ft-long adit are on the Eastern Star patented claim (pl. 1). The claim is owned by Glover-Hefner-Kennedy Oil Company of Oklahoma City, Oklahoma. No evidence of any recent mining activity was found, and a representative of Glover-Hefner-Kennedy indicated that there are no plans to further develop the claim (Glover-Hefner-Kennedy, oral communication, June 1991).

Four rock-chip samples were taken in the adit (fig. 4, nos. 40-43) and six more from the trenches and prospects (table 1, 36-

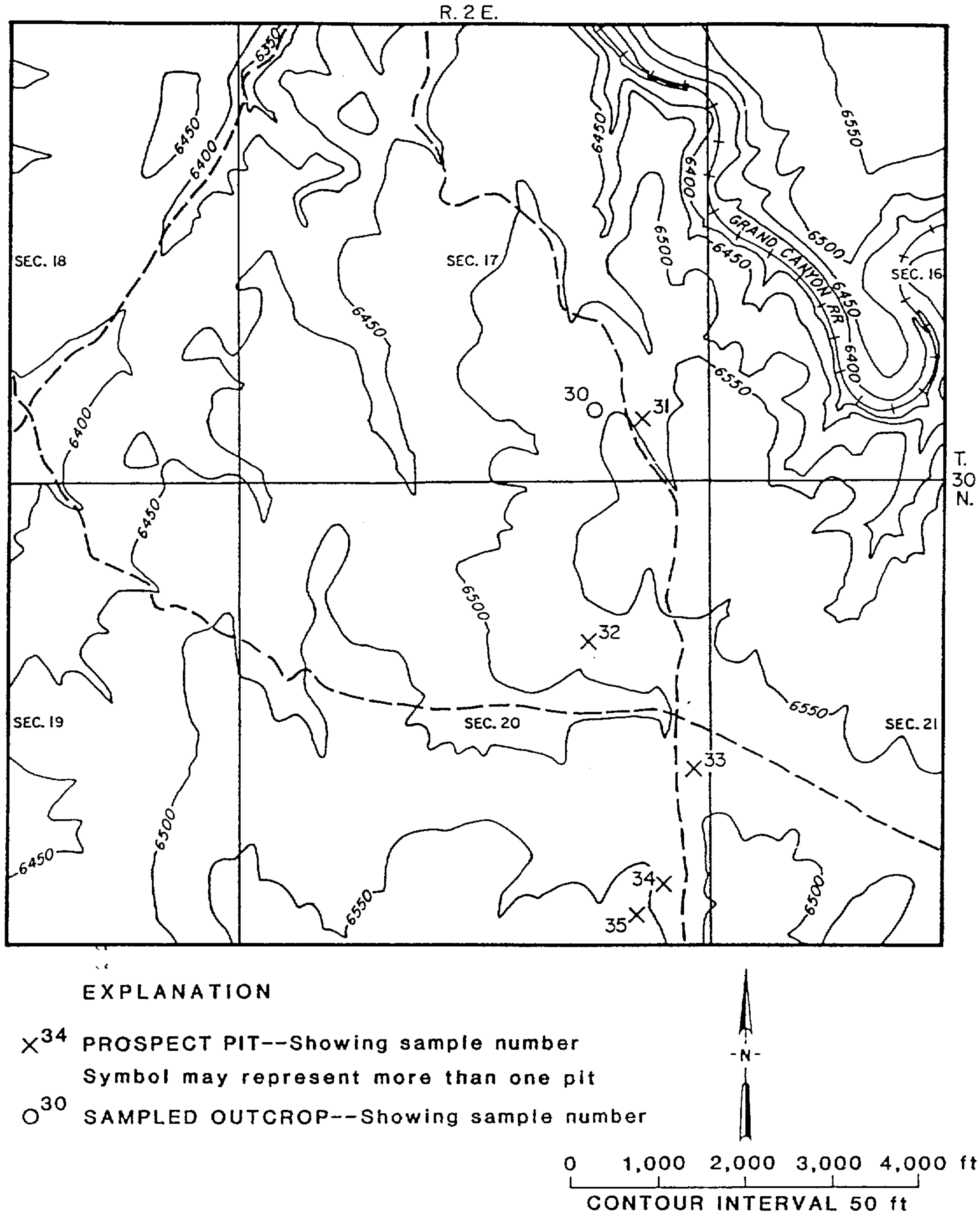



Figure 3. Map of the Coconino Wash area in the Francis mining district showing sample localities 30-35.

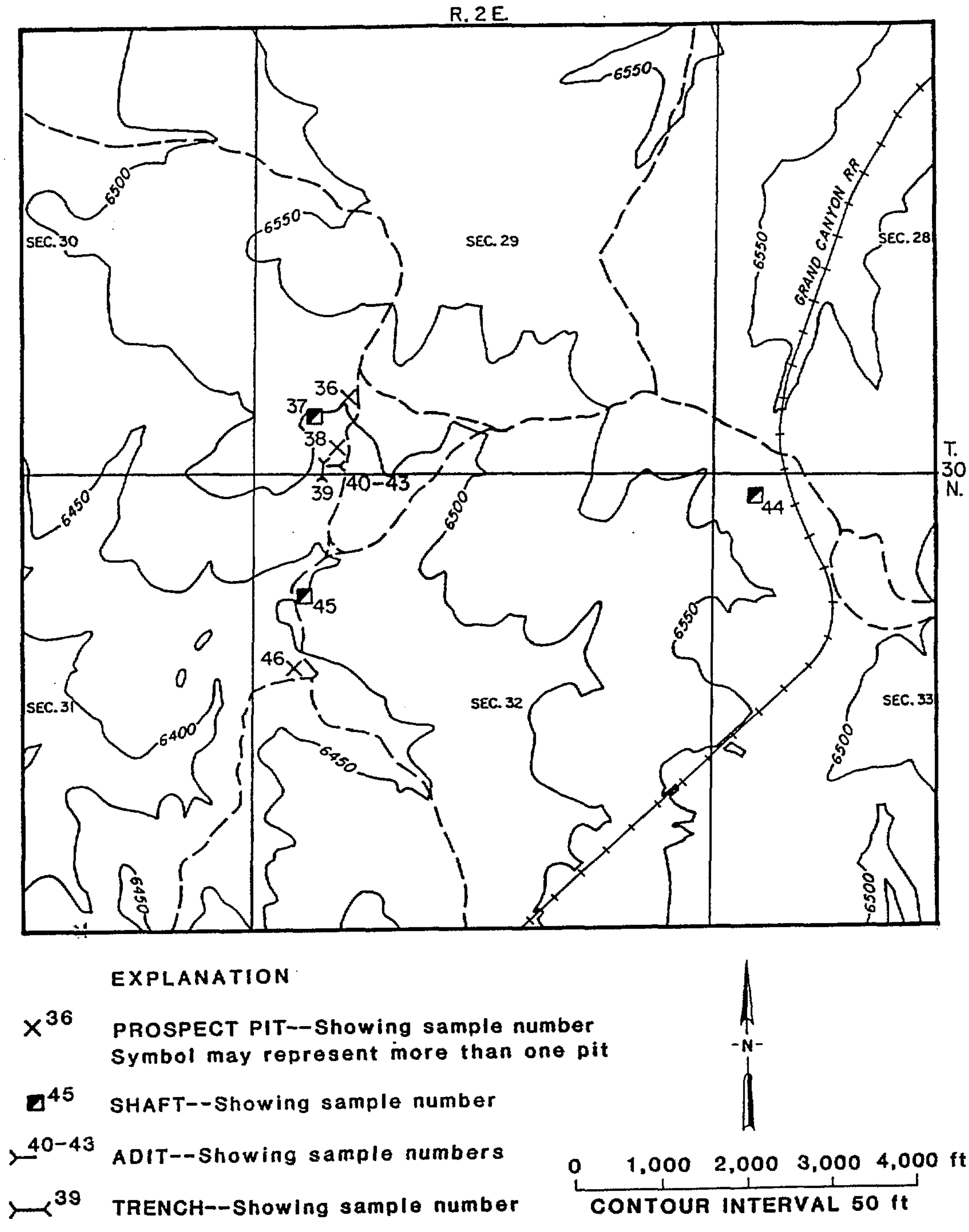



Figure 4. Map of the Eastern Star mine area showing sample localities 36-46.

39; 44-46). The 4 to 6 ft deep, up to 30 ft long, and 10-12 ft wide trenches appear to have been made with a bulldozer. Copper mineralization on the claims is characteristic of deposits previously described. The limestone in this area is brecciated; small lenses and stringers of azurite and malachite are present along breccia surfaces and bedding planes. A fault trending N 35° E in the adit was sampled and contained only 333 ppm (0.03%) copper (table 2). A sample (no. 40) of copper carbonates at the portal of the adit contained 2.29% copper. The fault in the adit may have some association with the brecciation observed in the area. Both the Bright Angel and West Kaibab faults are exposed to the north and trend toward these workings. It is possible that a series of faults, trending roughly north-south, are present in this area causing brecciation within the limestone beds. Copper-bearing fluids could then have percolated from above, mineralizing the brecciated areas. It should be remembered that copper mineralization is not wide-spread throughout the Forest but is present in a definite north-south trend.

As noted earlier, copper concentrations in the fault were low, indicating that the fault was probably just a mechanism for brecciation and was not a conduit for mineralization. Elevated uranium and arsenic concentrations are present in samples with high copper concentrations. Five of the ten samples contained elevated concentrations of gold.

## Anita Mine area

Conflicting information in the literature makes it difficult to determine the exact location of the Anita Mine. For the purpose of this report, the Anita Mine area includes all the workings from sample location nos. 48 to sample no. 83 (pl. 1). The Anita Mine area includes the Emerald Mine, the North Star shaft, and the Tellstar claims.

About 40 prospect pits and trenches, one short adit, and one 540-ft-deep shaft comprise the workings (pl. 1, fig. 5). The largest trench is about 150 ft long, up to 50 ft wide, and up to 12 ft deep. The shaft, known as the North Star Mine, is about 100 ft west of the large pit. It was not safely accessible; therefore no samples could be obtained to determine what, if any mineralized rock was intersected at depth. Dump material from the shaft includes gypsum, limestone, and sandstone, but no copper oxides. Copper concentration in the dump sample was only 47 ppm (no. 78, table 2). No significant concentrations of any metallic element of interest are present in the sample.

Copper mineralization exposed in the large pit and other pits at the Anita Mine area is the same as previously described (table 1). Copper concentrations in samples from the Anita Mine area ranged from 0.004 to 18.72% (table 2). The largest amount of copper was in a high-grade sample. Gold content ranged from less than 5 ppb to 36 ppb and silver from less than 5 ppm to greater than 50 ppm. Molybdenum concentrations were greatest in samples containing significant concentrations of uranium. Although some

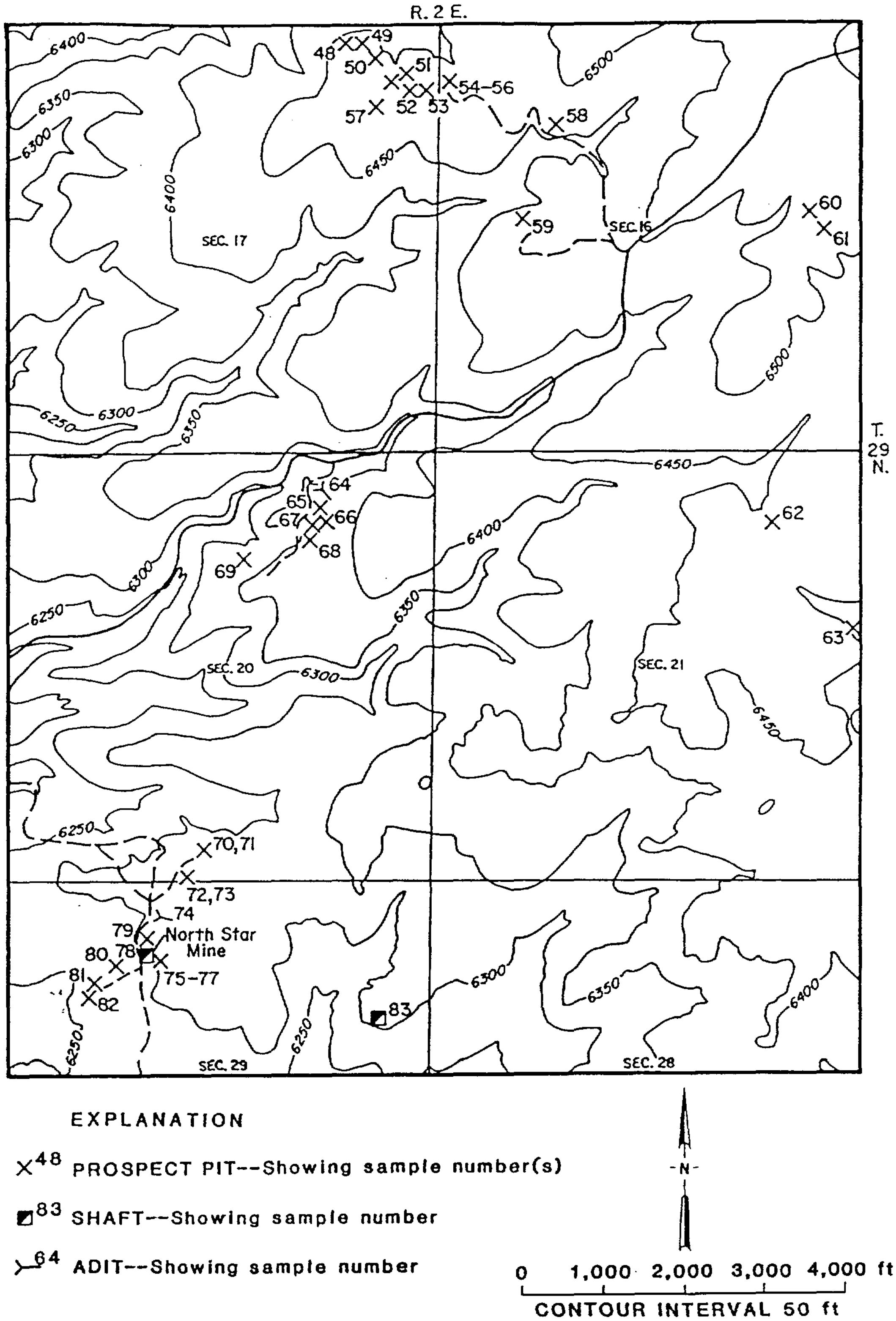



Figure 5. Map of the Anita mine area showing sample localities 48-83.

samples containing elevated concentrations of uranium were not high in copper, in most samples there does seem to be a relationship between elevated concentrations of copper and uranium. It has not been determined if the minerals were deposited at the same time or during separate mineralizing episodes.

## Copper Queen Mine (Blue Bonnet)

The Copper Queen Mine is about 3 mi south of the southern workings at the Anita Mine area (pl. 1, figs. 6A, 6B). A shallow open pit is the largest working of all the copper workings in this part of the forest. Three other smaller pits are just a few hundred feet north of the main pit. The mine is on a patented claim owned by Glover-Hefner-Kennedy Oil Company, Oklahoma City, Oklahoma. No evidence of recent mining activity was found and a representative from the company stated that there are no plans to further develop the claim (Glover-Hefner-Kennedy, oral communication, June, 1991).

The largest working at the Copper Queen is about 400 ft in length, up to 12 ft deep, and up to 50 ft wide. Copper minerals are in a brecciated limestone bed. Copper oxides occur as coatings on fracture surfaces and bedding planes of brecciated limestone; minor iron-oxide and manganese stains are also present. Six rock-chip samples were taken from the workings (fig. 6A, 6B, tables 2 and 3, nos. 84-89). Copper contents range from 0.26 to 8.09% (table 2). Molybdenum and uranium concentrations are also elevated in these samples.

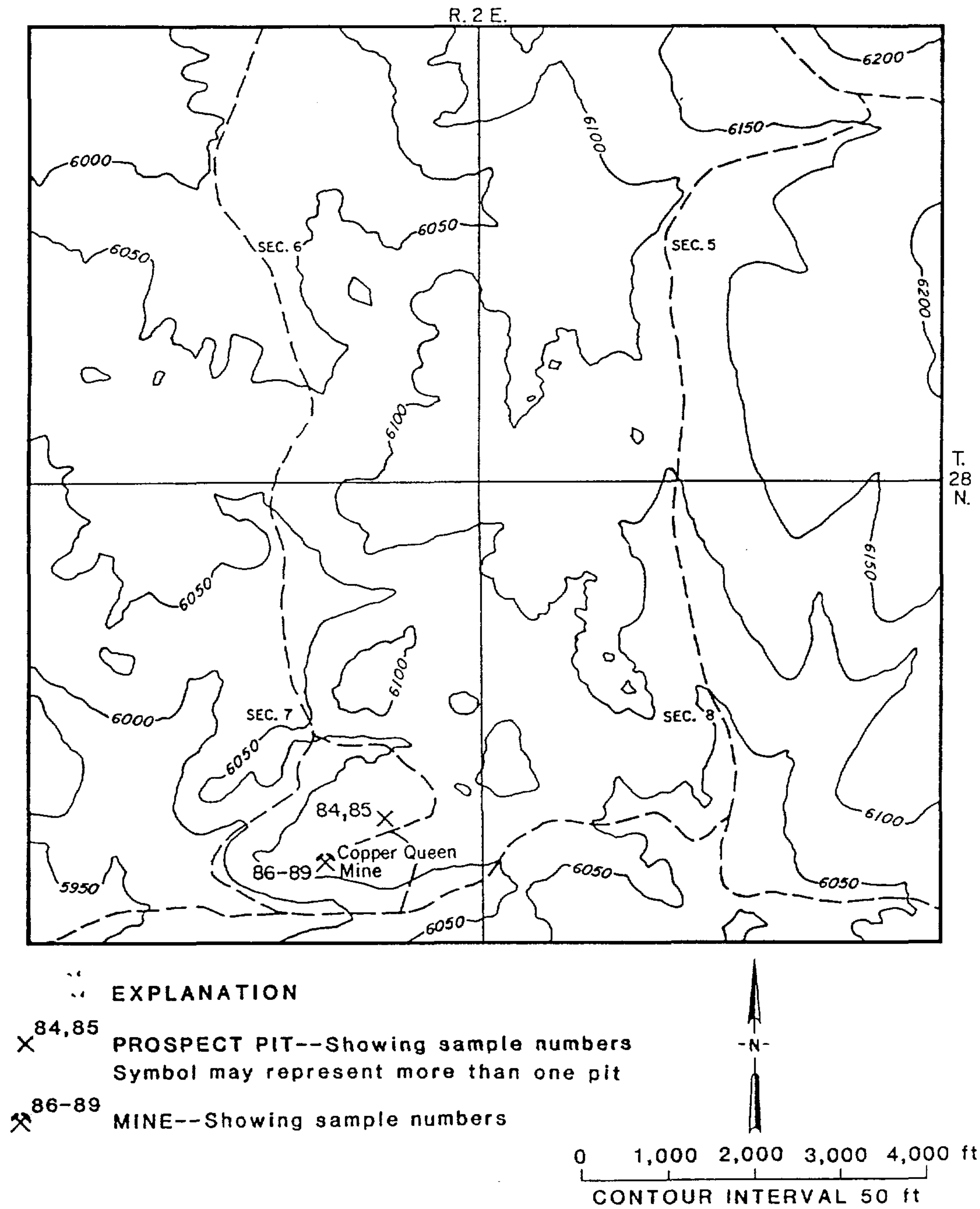



Figure 6A. Map of the Copper Queen Mine area showing sample localities 84-89.

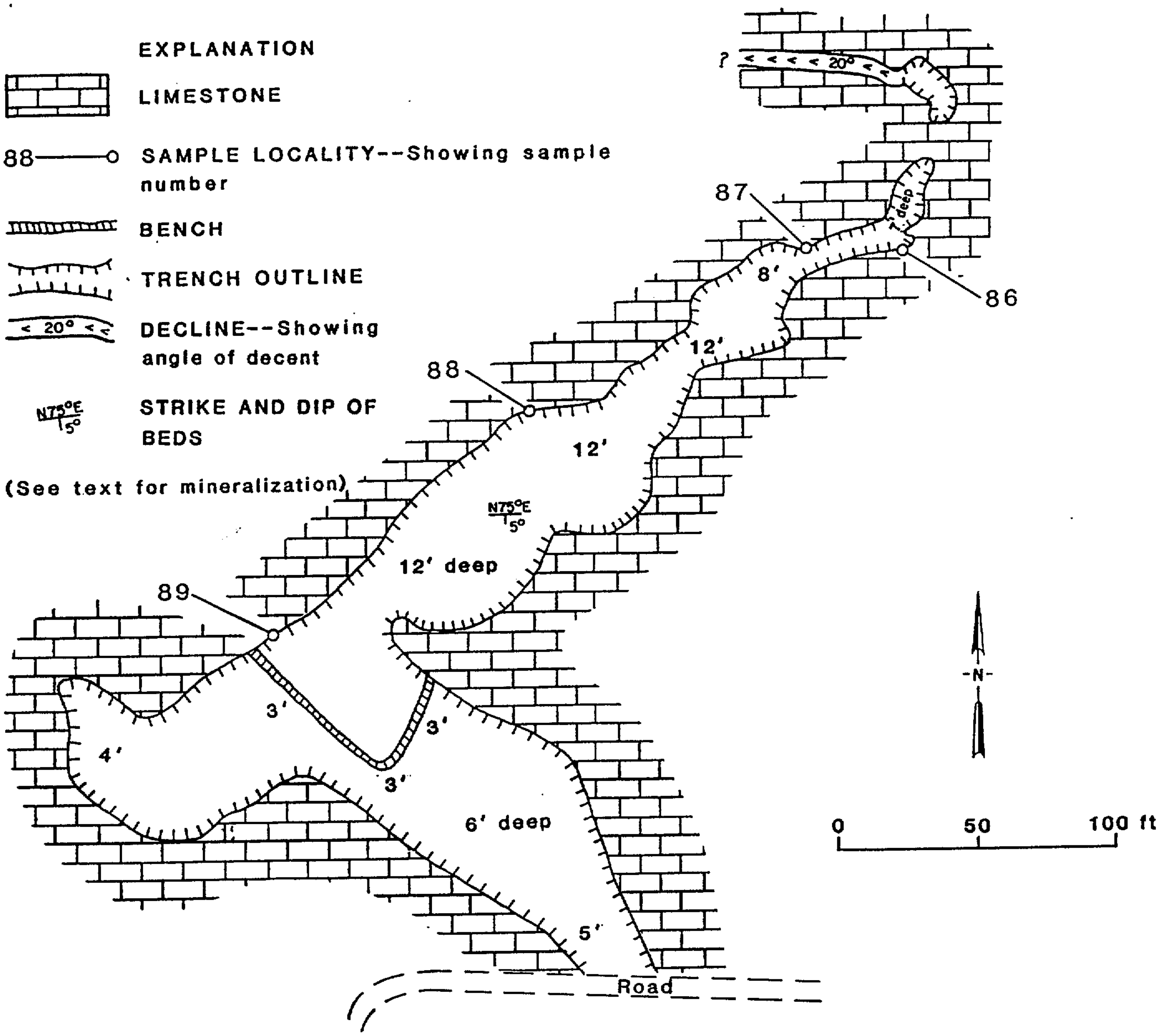



Figure 6B. Map of the largest working at the Copper Queen Mine area showing sample localities 86-89.

Although some select samples in the deposit contained significant concentrations of copper, the relatively thin beds containing the copper mineralization constitute too small a tonnage to make the deposit desirable for future development. Ground disturbance would be considerable and reclamation a primary cost concern.

### Miscellaneous occurrences

Prospect pits were found at two other locations in the Tusayan Ranger District. One pit is along the northeastern edge of the Tusayan district (pl. 1, no. 26, tables 2 and 3). The pit is 30 ft long, 15 ft wide, and about 8-9 ft deep. No evidence of mineralization was apparent; however, a fault zone trending N 15° W in red shale was sampled. The one rock-chip sample collected contained no unusual or significant concentrations of any elements of interest.

Four small prospect pits were found 5 mi southeast of the southern end of the Anita workings. Two rock-chip samples were taken from two of the pits (nos. 90-91, table 1). No unusual or significant concentrations of any elements were found (table 2), and no structure was apparent at the pits.

One sample (no. 47, table 1) of float material was taken 10 mi east of the Eastern Star Mine. The sample was found during a foot reconnaissance of the area. Although no copper oxides were visible in the material collected, analysis showed 0.06% copper (table 2). Manganese was the only mineral visible at this location and no outcrops were seen in this area.

## Industrial minerals

The Kaibab National Forest contains several industrial minerals, including volcanic cinders (scoria), basalt, sandstone (flagstone), pumice, sand and gravel, and limestone. Each commodity will be discussed separately.

### Volcanic cinders

Volcanic cinder is highly vesicular, reddish to black rock of mafic composition. It comprises extremely small crystals of feldspars, pyroxene, and glass in a groundmass of the same minerals. Volcanic cinder is formed when gases, especially water vapor, expand as molten lava is ejected from a volcanic vent during an eruption. The ejected material (tephra), including scoria, volcanic bombs and blocks, and lava, piles up around the vent and forms an elliptical to circular cone. Only moderately explosive eruptions produce economically useful cinder cones. (See Osburn, 1979, p. 75.)

The significant differences among scoria, bombs, and blocks lie in variations in size and texture of the materials. Scoria is made up of coarse to fine cellular clasts that range from 2 to 100 mm (4 in.) in diameter. Scoria includes both equant, fracture-bound fragments and elongate, glassy forms in this size range. Approximately 75% (by volume) of a cone is made up of scoria ranging from 10-50 mm in size. The remainder comprises blocks and bombs, lava flows, and minor amounts of volcanic ash. (See Osburn, 1979, p. 75.)

Most cinder deposits occur as cones or mounds of stratified fragments ranging from a fraction of an inch to several inches in diameter. Individual cones or mounds may be several hundred feet in diameter and up to 500 ft high (Peterson and Mason, 1983, p. 1079).

Volcanic cinder has a variety of industrial uses. Markets for cinder include aggregate for road construction and surfacing, use in lightweight concretes, particularly blocks, railroad ballast, and landscaping. Other uses are as adsorbents, asphalt mix, and roofing granules. One of the principal uses of volcanic cinder is in concrete admixtures used in the production of lightweight cinder blocks. Cinder is mined from an open pit using bulldozers and then stock piled, crushed to size and screened. It is then mixed with cement and water at the blockplant, pressed and stacked to make cinder blocks. In recent years, scoria has been used by the building industry as decorative stone in desert landscaping. The most accepted sizes of scoria used in landscaping are 3/4-in. and 1 1/4-in. clasts and large decorative blocks and bombs. Scoria used in landscaping requires careful size and color control and therefore commands much higher prices than scoria used for cinder block production. Generally speaking, reddish-brown scoria is preferred in the landscaping industry (Osburn, 1982, p. 58).

Because cinders are a construction material, the production and usage is dependent on the health of the construction industry. For instance, in 1978, 1,135,000 short tons of cinder and scoria were sold in Arizona. As the economy waned, so did the construction industry and the production of cinder. Production of volcanic cinders from 1982 to the present has fluctuated between 400,000 and 950,000 tons. During the last 20 years, Arizona has been ranked either first or second in total production of volcanic materials in the United States (U.S. Bureau of Mines Minerals Yearbooks, 1970-1990). Production since 1970 has been over 22 million st. Most, if not all, of this production is from the Kaibab and Coconino National Forests. The future market for volcanic cinders will be dependent on population growth in Arizona and neighboring states.

Cinder cones are present in the Williams and Chalendar Ranger Districts, but not in the Tusayan or North Kaibab Districts. The cinder cones are composed of five different geologic units ranging from Tertiary to Quaternary in age. To determine if cinder production favors one unit over the others, comparisons of geologic units of cinder cone versus actual mines on the cones were made. No single geologic unit was found to be exploited more than any other; therefore, geologic age of the cone does not seem to be an important consideration in mining cinders. Access, aspect ratio, transportation cost, volume of material in the cone, color, and size of the scoria are the determining factors in cinder mining.

Osburn conducted extensive research on cinder cones in New Mexico. Inspection of numerous cinder cones in that state suggested that there is a predictability in the physical properties of potentially minable cinder cone deposits. The physical properties studied included the aspect ratio of the deposit and color, sorting, and grain size of the tephra. Knowledge of each of these parameters could significantly lower both exploration and mining costs. (See Osburn, 1982, p. 58.)

Aspect ratio (Green, 1975) is defined as the ratio of height to average basal diameter of a volcano (Osburn, 1982, p. 58). According to Osburn (1982), cinder cones in New Mexico with aspect ratios between 0.1 and 0.2 were the best deposits. In general, cones with aspect ratios lower than 0.1 have thick lava flows included in them and approach the general configuration of shield volcanoes; those cones with aspect ratios greater than 0.2 tend to contain large amounts of agglutinate and approach the form of spatter cones. Agglutinate consists of scoria blocks stuck together with flow material. Large amounts of flow material and agglutinate must be blasted, but blasting increases costs and mining time and decreases mine safety. (See Osburn, 1982, p. 58).

There are more than 200 cinder cones within the Chalendar and Williams Ranger Districts and at least 37, or 18% of the cones, have had some mining development on them (pl. 2). Of the total number of cones, roughly 50% of them have an aspect ratio between 0.1 and 0.2. Of the total number of cinder pits (37), 75% of them had an aspect ratio between 0.1 and 0.2. Thus, the cinder cones with aspect ratios between 0.1 and 0.2 that are near existing roads, and that contain color characteristics needed by the producer will be the most desirable for future mining. The Kaibab National Forest contains virtually inexhaustible resources of cinder.

In recent years numerous mining claims have been staked for gold, reportedly occurring in the cinder cones in the Chalendar Ranger District. Several companies reported that cinder cones in these areas contained as much as 0.3 oz gold/st (11 ppm) (oral communication, Tom Gillete, Williams Ranger District, Williams, Arizona, May, 1990).

The Bureau of Mines sampled material in several cinder cones within the claims. Twenty-one samples of cinder were taken and analyzed by two different laboratories to compare possible gold and other metal contents (tables 2 and 3, samples 92-114). All samples were analyzed for gold by fire assay/atomic absorption spectroscopy by both Bondar-Clegg Laboratories of Lakewood, Colorado, and Chemex Laboratories of Sparks, Nevada. The detection limit for gold was 5 parts per billion (ppb). Only three samples were above the detection limit, but with concentrations of less than 14 ppb; this equates to 0.01 ppm or 0.0004 oz/st. Those samples were re-analyzed and 5 additional samples were taken from the cinders at those locations and were then assayed at the same laboratories to try to duplicate the original sample results. Gold was below the detection limit of 5 ppb in all the samples.

According to Boyle (1979) the range of gold concentrations in basalt and scoria (cinders, world wide) is between 0.0001 and 0.2300 ppm. The highest concentration in any sample taken by the Bureau was 0.01 ppm, within the normal or average range for gold concentration in cinders. Gold concentrations in the cinders in the Kaibab National Forest are average for normal crustal abundance of gold in this type of rock. It should also be noted that the samples that contained concentrations slightly above the detection limit of 5 ppb were analyzed again and the results could not be duplicated; therefore, it must be concluded that gold concentrations in these cinders is extremely low. The gold cannot be recovered economically.

## Basalt

Basalt is found throughout the Williams and Chalendar Ranger Districts. The basalt is a black to gray, dense to slightly vesicular extrusive volcanic material. Basalt flows in these districts contain virtually inexhaustible resources of material which could be used in road construction and other local construction uses. Currently, cinder cones are used for these purposes and the need for basalt is minimal.

## Pumice

Pumice is a product of an explosive volcanic eruption. It is produced by the violent expansion of dissolved gases in a viscous silicic lava, such as rhyolite or dacite, and is found relatively close to the vent from which it was expelled. It is a light-colored, cellular, almost frothy rock made up of glass-walled bubble casts. (See Peterson and Mason, 1983, p. 1079.)

Most pumice deposits are unconsolidated and usually have a minimum of overburden. Mining is by open pit using conventional loading equipment. Sometimes air drying precedes hauling to a crushing and screening plant which yields the size product desired. Pumice for abrasive use may require more sophisticated processing such as fine grinding and air classification, before being bagged for market. (See Peterson and Mason, 1983, p. 1079.)

Low bulk density, good heat and sound insulating properties, and excellent abrasive capabilities make pumice desirable in many industrial and manufacturing uses. One of the primary uses has been in the construction industry as road-surfacing material, railroad ballast, and building block aggregate. Pumice is also used in the manufacture of paint, chemical industry, metal and plastic finishing industry, compounds in the rubber industry, manufacturing of glass and mirrors, the furniture industry, electronics industry, manufacturing of pottery, and in the agricultural industry. (See Peterson and Mason, 1983, p. 1080.)

The garment industry uses clean lump pumice to abrade and soften denim fabric for "stone washed" and "faded" jeans. Pumice impregnated with oxidizing chemicals is used to bleach and abrade denim fabric for "acid washed" jeans. Both processes impart the currently popular "worn" or "lived-in" look to denim clothing. (See Strathy, 1990; Hoffer, 1991.)

Because pumice is a low value construction and manufacturing material, production and usage is dependent on the national economy. There has been no recorded production of pumice from Coconino County; however, one or two operations have been reported. Production figure reports are not mandatory; therefore, it is difficult to determine actual production.

Within the Kaibab National Forest, the San Francisco volcanic field contains isolated occurrences of pumiceous material, which Newhall and others (1987) identified as Tertiary-age airfall deposits of pumiceous dacite lapilli and fine ash. Pumice fragments were observed in float during Bureau reconnaissance of mapped pyroclastic units east of Sitgreaves Mountain, on RS Hill, and near Frenchy Hill. On the east flank of Bill Williams Mountain, pumiceous material is exposed in a number of small pits and trenches on Forest Service land and in an operating quarry on private land.

In 1989, the Forest Service examined mining claims located for pumice in sections 15 and 16, T. 21 N., R. 2 E. on the east flank of Bill Williams Mountain. At issue was whether the pumiceous material was locatable under the General Mining Law or salable under the Mineral Material Act. Based on an exhaustive examination that included site geology, an evaluation of analytical data for channel and grab samples, and a review of market data, the pumiceous material was designated a common variety of stone, salable and non-locatable. (See Strathy, 1990.)

Samples of pumiceous material from the Bill Williams Mountain claims were tested by Dr. Jerry M. Hoffer, at the University of Texas, El Paso, Texas. Dr. Hoffer ranked the material based on density, hardness, abrasion loss, effective porosity, and impregnation rate values (Table 4.) for comparison with material ranked the same way from 14 other U.S. and foreign pumice sources. Material from the mining claims ranked last compared to the other samples in terms of suitability for use in the garment finishing industry (Hoffer, 1990).

Table 3.--Analytical data for pumice material from the east flank of Bill Williams Mountain, Arizona (Hoffer, 1990).

| Physical Property | Samples | Range | Average |
|---|---|---|---|
| Surface Fines (%) | 2 | 0.1-1.4 | 0.7 |
| Density ($g/cm^3$) | 5 | 0.66-1.07 | 0.92 |
| Porosity (%) | 2 | 9-18 | 14 |
| Effective Porosity (%) | 5 | 8-17 | 12 |
| Abrasion Loss (%) | 2 | 1.9-3.3 | 2.6 |
| Hardness (mm penetration) | 2 | 1.0-1.1 | 1.1 |
| Impregnation Rate (%wt/min) | 5 | 1.6-3.5 | 2.3 |

It should be noted that the value of pumice to the garment finishing industry is linked to the vague concepts of fashion and style. As Hoffer (1990) pointed out, there is no 'best' pumice for producing all of the fabric styles that are fashionable at a given time. Also, there is no way of predicting what fabric style will be fashionable in the future.

The high density and low porosity of pumiceous material from the occurrence on the east flank of Bill Williams Mountain probably limits its uses to local landscaping and road construction. However, the physical properties of pumiceous deposits can vary dramatically over short distances and exposure of this occurrence is limited.

Sandstone

Flagstone (sandstone) is a consolidated sand in which the grains are composed chiefly of quartz and feldspar. The rock has fragmental texture with various interstitial cementing materials, including silica, iron oxide, calcite, or clay (Power, 1983, p.166.)

Due to the uniformity of flagstone and its resistance to weathering and abrasion, flagstone has been used widely in the United States as a building stone. Large solid blocks, either rough or dressed, are extracted from massive sandstone beds. Smaller blocks and slabs used for facing, trim, steps, window sills, caps, and coping are produced from bedded sandstones that are easily split or cut into special shapes. Ashlar is a term used for cut or sawed and squared sandstone blocks similar to bricks, that can be used for facing in walls, chimneys, fireplaces and general decorative landscaping. Various color and textural patterns can be created from ashlar, so some producers sell it in unit amounts of various colors and sizes. Crushed and broken sandstone has little use except as fill rock and some other miscellaneous and minor uses. (Keith, 1969, p. 441.)

Sandstone is extracted from quarries where it is split out in large sheets or blocks, the size dictated by the spacing of the natural planes of weakness. These blocks or sheets may be further split and cut to desired sizes and shapes. Inherently, the quarrying and preparation of dimension sandstone wastes a large amount of the stone--as much as 60% in many operations. (See Keith, 1969, p. 443.)

The U.S. Bureau of Mines includes all forms of building stone under the general classification of dimension stone. At the beginning of the century dimension stone accounted for more than half the stone produced in the United States, but by 1981 it accounted for little more than 0.1%, and the number of producing quarries and finishing plants had greatly decreased. (See Power, 1983, p. 161.) Good dimension flagstone has been produced in northern Arizona since before 1900 and, up to 1966, has amounted to over 350,000 st with a value of over $4 million. (See Keith, 1969, p. 444.)

Sandstone occurs as part of the Coconino Sandstone in the Kaibab National Forest and is found in two separate locations. One is north of Ashfork, Arizona and contains hundreds of pits and small- to medium-size excavations. The Coconino Sandstone is at least 245 ft thick in the Ashfork area. Mining at the present time is at relatively shallow depths, probably not exceeding 20 to 40 ft below the surface. Several short tons to many hundreds of short tons of flagstone have been removed from the pits. Approximately 20 $mi^2$ of the Ashfork area is underlain by the sandstone. The other area of the Forest is known as the "Drake" area and is about 15 mi southwest of the town of Williams, Arizona. The sandstone is probably less than 245 ft thick in this area. Several hundred pits and small- to medium-size excavations have been dug in this area. Approximately 6 $mi^2$ of the Drake area is underlain by the sandstone. Production from the pits has been quite variable with several short tons to many hundreds of short tons of flagstone removed from the pits. Production data are not required to be reported; therefore, it is difficult to determine production. Historically, there have been between four and eight producers per year. Production is in the thousands of tons per year.

Flagstone in the Ashfork area is more reddish colored than the tanner colored material in the Drake area. The material is mined from both areas according to desired color, texture, and ease of mining. Ease of mining means that the most desirable deposits are those where the flagstone beds dip towards the mining face, thus employing gravity to help to slide the blocks towards the splitting and loading area.

The two flagstone areas in the Kaibab National Forest contain virtually inexhaustible resources of flagstone. Construction, based on the health of the economy, will dictate the usage of flagstone in the future. At the present time, only those resources that are easily accessed are being mined. In the future, as demand persists, the flagstone could become more expensive as deeper quarrying will be needed to extract the material.

## Limestone

Carbonate rocks (limestone and dolomite) are the material from which aggregate, cement, lime, and building stone are made. Carbonate rocks, and their derived products, are used as fluxes, glass raw material, refractories, fillers, abrasives, soil conditioners, ingredients in a host of chemical processes, and much more. Limestone and dolomite have a large number of uses; however, certain uses have special chemical requirements, which specify the quantity of calcium carbonate and magnesium carbonate, or both, in the rock, along with the maximum percentage of impurities that can be tolerated. (See Carr and Rooney, 1983, p. 833.)

Kaibab Limestone underlies most of the North Kaibab and Tusayan districts. Some of it may be suitable for use in the cement industry; however, transportation costs alone would prohibit development of any deposit. There are virtually inexhaustible resources of limestone in the Forest; however, because most of the limestone contains impurities, it is suitable only for use in road construction.

Sand and gravel

Sand and gravel is produced by the disintegration of rock. Transportation of the disintegrated rocks is mainly by stream flow, sheetwash, and wind. The predominant rocks in the Kaibab National Forest are essentially flat-lying sandstone and limestone and extensive basaltic flows and cinder cones. In general, these rocks produce sand but little gravel. Because gravel is scarce in the Forest, volcanic cinders and scoria, which are widely available and more accessible, are used extensively as a substitute for gravel. No resources of gravel in the sense just described are present in the Forest. Sand is found in drainages, but not in large quantities.

## Conclusions

About 90% of the North Kaibab and Tusayan Ranger Districts are underlain by Permian-age Kaibab Limestone. The rest of the areas are covered by younger-age sediments. Geologic structure in these districts is simple. Copper is the most predominant base metal in the Kaibab National Forest. The copper occurs stratabound within siliceous intraformational breccia horizons of the Kaibab Limestone. Secondary copper carbonates and silicates coat breccia fragments and bedding plane surfaces within these horizons. The horizons occur approximately 5 to 10 ft below the surface and the average thickness is between 4 and 6 ft. The copper deposits form a roughly north-south linear trend that is about 13 mi long. Most of the deposits are small, probably not exceeding 100 short tons each in size.

Economic evaluation of the copper properties in the forest show that development of all known deposits of this type in this region has not been economically feasible. The small tonnages make these deposits unattractive for future development.

Volcanic cinder (scoria) is present throughout the Williams and Chalendar Ranger Districts. There are more than 200 cinder cones in these areas and at least 37 cinder pit excavations known to exist on those cones. Of the total number of cones, roughly 50% of them have an aspect ratio between 0.1 and 0.2. The cinder cones with aspect ratios between 0.1 and 0.2 that are near existing roads and that contain color characteristics needed by the producer will be most desirable for future mining. The Kaibab National Forest contains virtually inexhaustible resources of cinder. Basalt is found throughout the Williams and Chalendar Ranger Districts.

Gold concentrations in the cinders are average for normal crustal abundance of gold in scoria and basalt. From 23 Bureau samples, only three contained slightly elevated concentrations of gold. These samples were analyzed again and the results could not be duplicated. It is concluded that gold concentrations in these cinders is economically insignificant.

Pumice is found in the Chalendar Ranger District. Pumice fragments were observed in float during Bureau reconnaissance of mapped pyroclastic units east of Sitgreaves Mountain, on RS Hill, and near Frenchy Hill. On the east flank of Bill Williams Mountain, pumiceous material is exposed in a number of small pits and trenches. Based on an exhaustive examination of this pumice occurrence by the Forest Service, the material was designated a common variety of stone. The high density and low porosity of pumiceous material from this location probably limits its uses to local landscaping and road construction. It should be noted however, that the physical properties of pumiceous deposits can vary dramatically over short distances and exposure of this occurrence is fairly limited.

Sandstone is found in two areas of the Williams Ranger District. Thousands of tons of material have been removed throughout the years. Approximately 20 $mi^2$ of the Ashfork area and 6 $mi^2$ of the Drake area are underlain by thick (up to 245 ft) accumulations of flagstone. These two areas contain virtually inexhaustible resources of flagstone.

Although the Tusayan and North Kaibab Ranger Districts are underlain by limestone, the material is not suitable for general industry use and is better suited for road fill, etc. Sand and gravel deposits are found in the stream channels throughout the forest. Because of the geologic environment, mostly sand is found within the stream channels; therefore, volcanic cinders are crushed and substituted for use in construction of roads.

## Breccia Pipes

The North Kaibab and Tusayan Ranger Districts are within in a geologic environment where uranium-mineralized solution-collapse breccia pipes have been mined. The following section is summarized in part on the origin and description of these geologic features as described by Wenrich (Wenrich and Almquist, unpublished U.S.G.S. Open File report, 1992).

### Introduction

Breccia pipes are found in Paleozoic rocks in the southwest part of the Colorado Plateau province in northern Arizona (Wenrich and Sutphin, 1988, p. 1). A fraction of these breccia pipes are host to high-grade uranium deposits, from which over 17 million pounds of $U_3O_8$ have been produced since 1940 (Wenrich and others, 1990, p. 5) (fig. 7). The North Kaibab and Tusayan Ranger Districts are within this geologic environment where breccia pipes have been discovered. The search for uranium-mineralized breccia

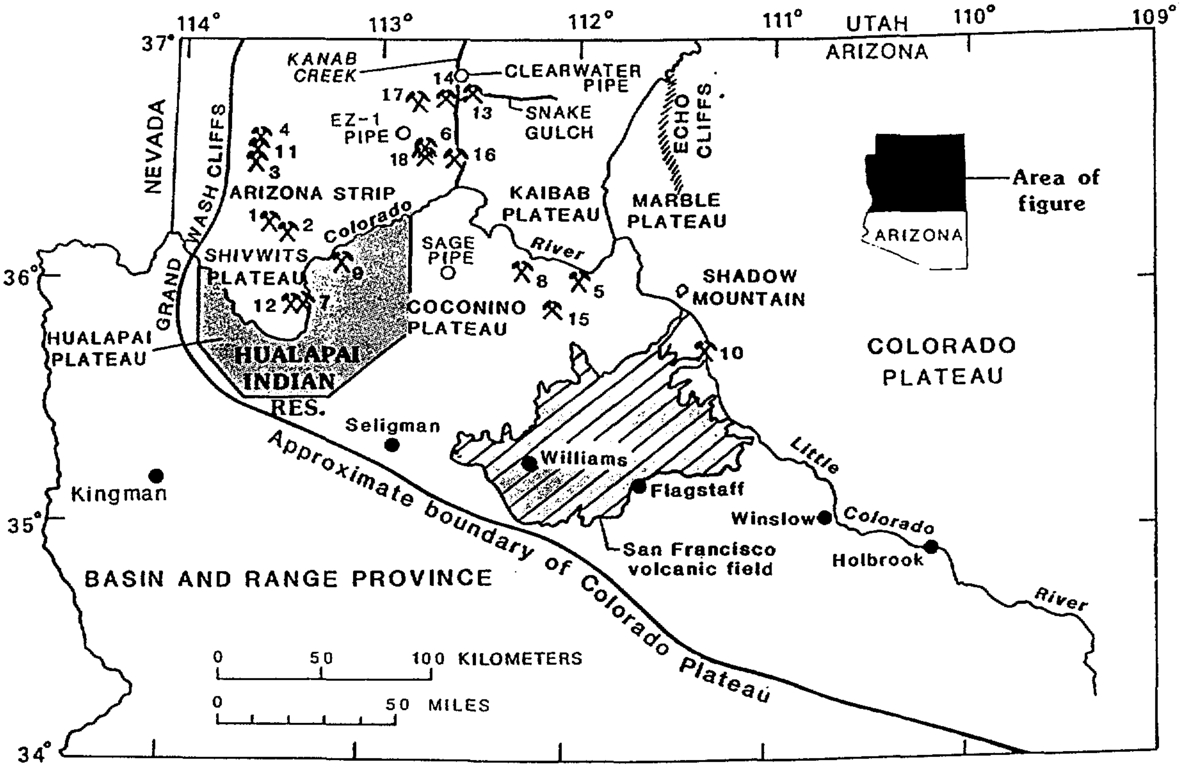



Figure 7. Index map of northern Arizona showing the locations of plateaus, Hualapai Indian Reservation, breccia pipes developed into mines. Numbers refer to the following mines: (1) Copper House, (2) Copper Mountain, (3) Cunningham, (4) Grand Gulch, (5) Grandview, (6) Hack Canyon, (7) Old Bonnie Tunnel, (8) Orphan, (9) Ridenour, (10) Riverview, (11) Savannic, (12) Snyder, (13) Pigeon, (14) Kanab North, (15) Canyon, (16) Pinenut, (17) Hermit, and (18) Arizona 1. (From Wenrich and Sutphin, 1988).

pipes and understanding their origin are some of the most unique challenges facing exploration geologists today (Krewedl, 1986, p. 179). The Tusayan Ranger District contains nine breccia pipes that are mineralized with uranium (fig. 8). Of these, the Canyon pipe, contains a high-grade uranium deposit with associated Ag, Cu, Pb, V, and Zn. A mine permit has been approved and issued to Energy Fuels Nuclear Inc. for this deposit and a headframe for the shaft is in place.

Breccia pipes commonly have a circular topographic expression, referred to as a circular feature in this report. Such circular features can be identified on aerial photographs and can be an exploration guide. Although thousands of circular features occur within Mississippian- to Triassic-age formations in Northern Arizona, only a very small fraction of those are actually breccia pipes; morever, even fewer may be significantly mineralized (Krewedl, 1986, p. 1). Energy Fuels Nuclear Inc. have identified over 4,000 circular features in the Arizona Strip area. Drilling was done on about 400 of those features, confirming only 70 breccia pipes; a fraction of those were actually mineralized (oral communication, 1992, Bob Schaffer of Energy Fuels Inc. and John Cottrell of Pathfinder Mines Corp.).

The Bureau of Mines, aided by an aerial photographic interpretation by Petroleum Information Corporation, conducted a study to identify and evaluate circular features in the Tusayan Ranger District. These features can then be further examined on the surface to delineate areas which may contain breccia pipes.

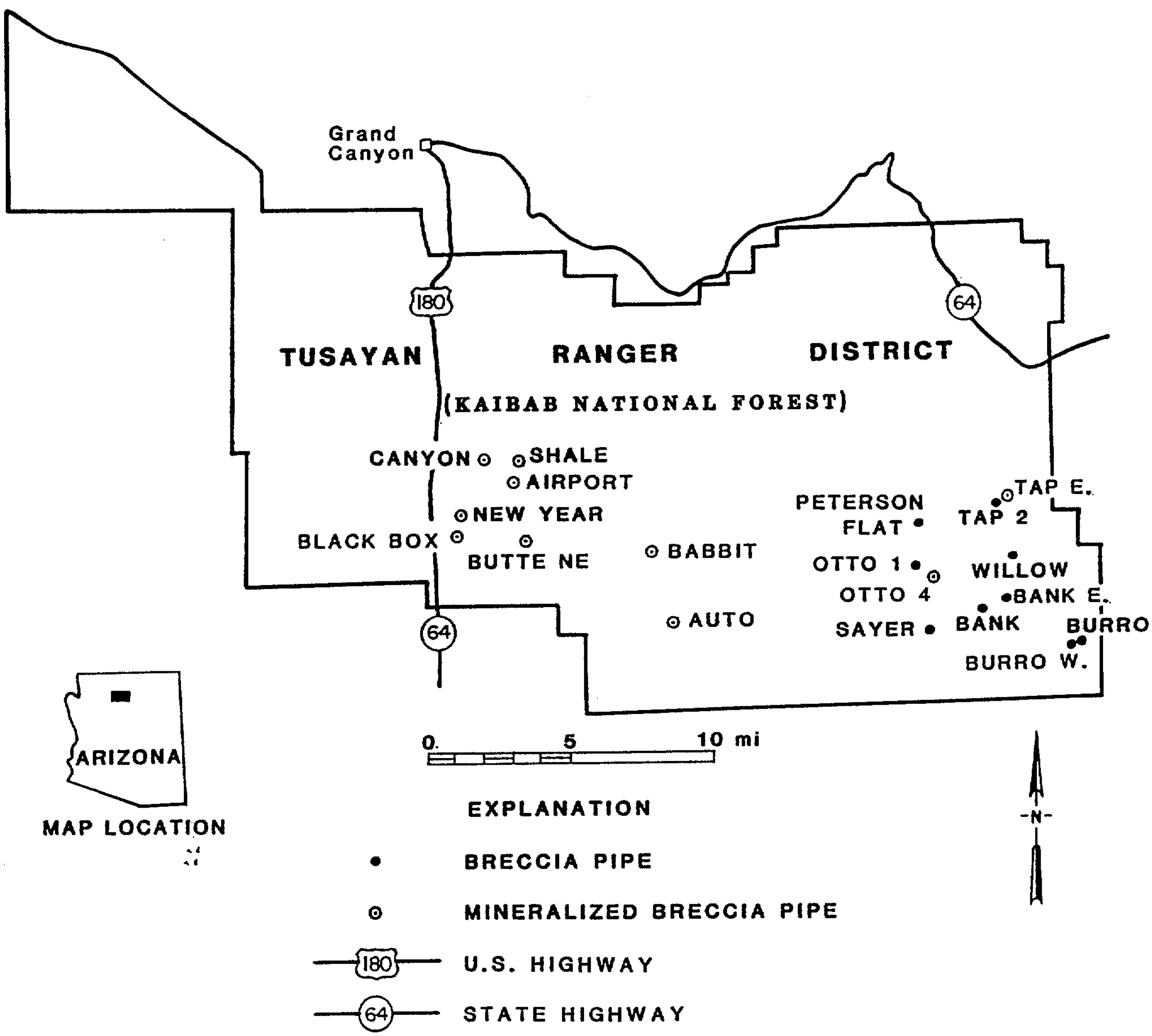



Figure 8. Map showing breccia pipe locations in the Tusayan Ranger District. (From Energy Fuels Inc. and Pathfinder Mines Corp., 1992).

Drilling would be needed to prove conclusively that the identified surface feature is a breccia pipe, much less a mineralized breccia pipe. The goal of this study, therefore, is to show the Forest Service which areas of the forest might contain breccia pipes based on location of circular features identified on aerial photographs. The entire Tusayan Ranger District has already been extensively explored by mining companies. Based on that fact, it would be expected that less exploration would take place in the future. It must be emphasized that the accompanying data and plate on circular features is neither a map of breccia pipes nor is it intended to be used in any manner to suggest uranium resources or reserves.

The North Kaibab Ranger District was not examined by aerial photographic interpretation because of the heavily forested terrain. The Williams and Chalendar Ranger Districts were not examined because they are within the San Francisco Volcanic field and any solution-collapse breccia pipes would be buried beneath the volcanic rocks. The Tusayan Ranger District was the only part of the Kaibab National Forest that was examined in this manner.

Mining activity associated with breccia pipes

One of the earliest breccia pipes to be mined in the vicinity of the Kaibab National Forest was the Orphan Mine in the Grand Canyon. The Orphan Mine is about 3.5 mi north of the northern boundary of the Tusayan Ranger District. In 1893, the deposit was mined for copper and minor amounts of silver, lead, and zinc. Uranium was noted in the old workings by the U.S Geological Survey in 1951. Subsequent drilling proved that the deposit was a vertical collapse-breccia pipe that penetrates the Permian and Pennsylvanian strata of the Grand Canyon. Uranium production from the mine commenced in mid-1956 with production of about 1,000 st-per-month, averaging 1.00 % uranium oxide ($U_3O_8$). During the period 1956-1969, uranium production from the breccia pipe amounted to 495,107 st of ore averaging 0.42% $U_3O_8$, and containing 4.26 million lbs of $U_3O_8$. In addition to the uranium, 6.68 million lbs of copper, 107,000 oz of silver, and 3,400 lbs of vanadium oxide were recovered from the ore. (See Chenoweth, 1986, p. 1-2.)

On the north side of the Grand Canyon, during the early 1980's, the Hack 1, 2, and 3, and Pigeon pipes were brought into production (fig. 7). Between January 1980 and August 1988, these four mines had a cumulative production of over 13 million lbs of $U_3O_8$ at an average grade of 0.65% $U_3O_8$. Production from the Kanab North and Pinenut Hermit Mines commenced in the mid-1980's. (See Wenrich and others, 1990, p. 763).

## Location

Breccia pipes in the Kaibab National Forest are located in flat-lying strata in areas where deformation consists of folding, possible broad regional warping, and local deformation of the Kaibab Limestone paleo-surface. These structures are found from the Grand Wash Cliffs (western margin of the Colorado Plateau) to the Echo Cliffs, and from the Mogollon Rim (southern margin of the Colorado Plateau) to the Utah border (fig. 7). The North Kaibab and Tusayan Ranger Districts are in an area where permissible geologic features for the occurrence of breccia pipes exist. The Chalendar Ranger District is within part of the San Francisco volcanic field and although pipes have not been identified within the volcanic field, they could be buried beneath the lavas. (See Wenrich and Sutphin, 1988, p. 1.)

Description and origin

Breccia pipes in the Kaibab National Forest are collapse features that resulted from the dissolution of the Redwall Limestone, which formed caverns, followed by progressive stoping, or gravitative collapse, of the overlying strata. The collapse of the strata produced a collapse cone (ring fracture) around a steep-walled, pipelike structure that was filled with angular to rounded fragments ranging from totally comminuted material to building-size boulders (fig. 9). None of these pipes contain rocks from underlying formations; all the rocks have been dropped downward into the pipe. (See Wenrich and Sutphin, 1988, p. 1.)

Analyses based on observations of exposures on canyon walls and drilling results demonstrate that breccia pipes consist of two interrelated parts: the throat and the collapse cone. The throat of the breccia pipe is defined as that volume within which the rocks have been brecciated and displaced downward with respect to the surrounding rocks. The collapse cone is that volume of rock above the Coconino Sandstone and surrounding the throat, which has been structurally deformed. This collapse cone is referred to as

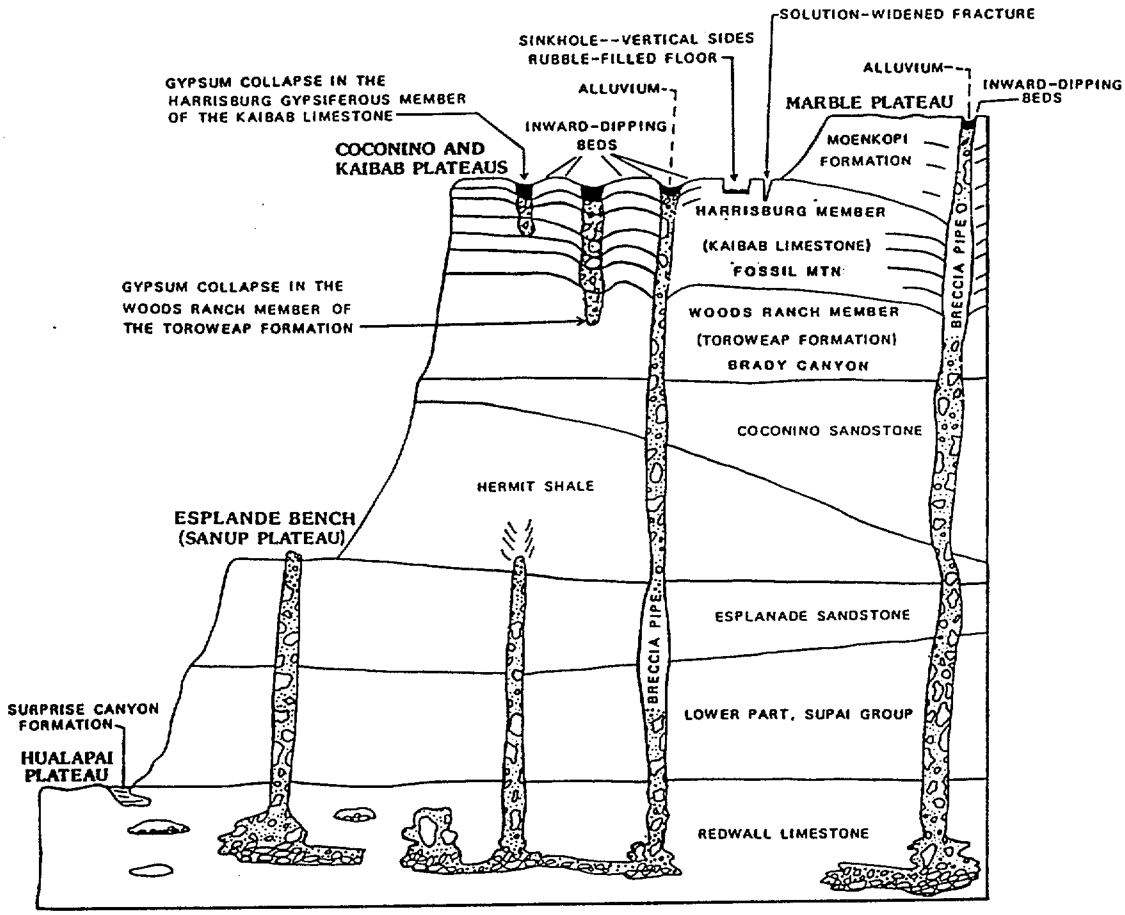



Figure 9. Diagram showing the various types of solution-collapse features found in northwestern Arizona: (1) Breccia pipes that bottom in the Redwall Limestone, (2) Collapse due to dissolution of gypsum beds in the Woods Ranch Member of the Toroweap Formation, (3) Collapse due to dissolution of gypsum beds in the Harrisburg Gypsiferous Member of the Kaibab Limestone, and (4) Collapse (with vertical sides, as opposed to the gently-sloping sides of the other 3 collapse types) due to recent sinkholes in the limestone beds of the Kaibab Limestone. (Illustration is from Wenrich and others 1990).

a circular feature in the remainder of this report. (See Krewedl, 1986, p. 181-182).

Dissolution of the Redwall Limestone commenced about 330 million years ago (late Mississippian), creating an extensive karst terrain with closed depressions, sinkholes, caves, and underground drainage. Dissolution of the limestone and subsequent collapse of the overlying strata continued throughout either the late Paleozoic and early Mesozoic, or ceased after the Mississippian and was reactivated during the late Triassic. Pipes have not been found in rocks younger than Triassic-age; such rocks have been removed by erosion throughout most of northwestern Arizona. (See Wenrich and Sutphin, 1988, p. 1-2.)

Breccia pipes transgress all formations from the Redwall Limestone to the Chinle Formation. Many pipes provide continuous profiles through more than 800 ft of sedimentary rocks; however, nowhere in the Grand Canyon area does an exposure reveal a pipe cutting through 3,000 ft of sedimentary rocks. The average diameter of breccia pipes in the area is about 200-300 ft; however, many collapse features or circular features, up to 0.5 miles in diameter, are found surrounding breccia pipes (fig. 10). (See Wenrich and Sutphin, 1988, p. 2.)

## Mineralization

Uranium mineralization in breccia pipes is confined largely to the lower parts (Coconino, Hermit, and Supai Formations) of the pipes. It is because of this fact that breccia pipes are difficult

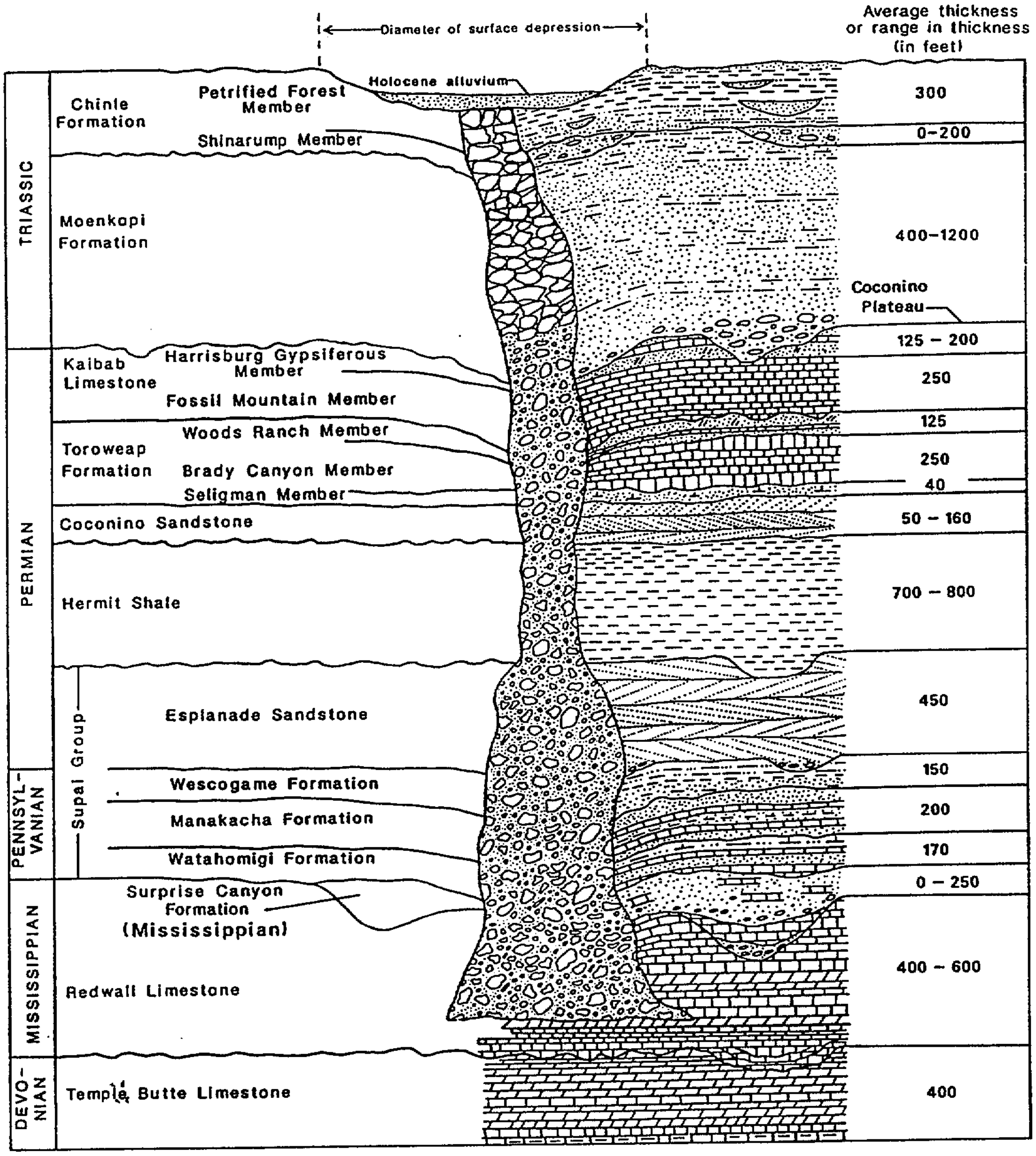



Figure 10. Schematic cross section of a breccia pipe (based on Cliff exposures in the Grand Canyon of Arizona). The unit thicknesses shown for the Triassic Chinle and Moenkopi Formations represent their thickness ranges in the Grand Canyon area. The unit thicknesses for the Paleozoic strata correspond to thicknesses that occur on the Coconino Plateau (from Wenrich, Billingsley, and Huntoon, 1986, which also provides unit descriptions). (Cross section is from Van Gosen and Wenrich, 1989).

to identify from surface examinations. In most cases, no mineralization of any type is present at the surface of these pipes. Various metallic minerals in the pipes were probably deposited by at least two separate mineralizing fluids. The primary uranium-mineralizing event probably occurred after deposition of the Triassic-age Chinle Formation. Numerous U-Pb isotopic analyses from the Hack 1, Hack 2, Kanab North, EZ-1, EZ-2, and Canyon pipe deposits shows that the primary uranium-mineralizing event occurred about 200 m. y. ago. Petrographic investigations suggest that uranium mineralization occurred after that of cobalt, copper, iron, lead, nickel, and zinc. Erosion in the Grand Canyon exposed and oxidized the ore in many pipes, which in turn produced the beautiful secondary copper minerals that interested prospectors in the 1800's. (See Wenrich and Sutphin, 1988, p. 2.)

The presence of supergene copper minerals may not indicate a uranium deposit. This is generally true in the western Grand Canyon area, where many pipes have been dissected and entirely oxidized. At these locations the primary ore minerals, including uranium, have either been thoroughly oxidized or uranium was never deposited. (See Wenrich and Sutphin, 1988, p. 2.)

## Surface recognition

Breccia pipes are most clearly visible in canyons where erosion has exposed their vertical configuration; however, the Tusayan and North Kaibab Ranger Districts are composed of undissected portions of the Kaibab and Coconino Plateaus. Recognition of pipes in this terrain is therefore complicated because of the lack of any vertical exposures. Recognition of these pipes is further complicated by the development of karst depressions in the Kaibab Limestone and Moenkopi Formation and collapse features rooted in the gypsum of the underlying Toroweap Formation. (See Wenrich and Sutphin, 1988, p. 3.)

Both solution-collapse breccia pipes and shallow-seated gypsum collapses have the appearance of a circular pattern when viewed on an aerial photograph. To assist in distinguishing solution-collapse breccia pipes from shallow-seated gypsum collapses, circular features, once identified in the field, can be placed into categories depending on such physical characteristics as: (1) concentrically inward-dipping beds that generally surround a basin, (2) amphitheater-style erosion, (3) concentric drainage, soil, and vegetation patterns, (4) altered and mineralized rock. It should be noted, however, that each circular feature may possess all, some, or none of these characteristics at the surface. (See Wenrich and Sutphin, 1988, p. 3.)

Aerial photo interpretation

As previously discussed, circular features in the Kaibab Plateau can be associated with breccia pipes which may contain uranium. An aerial photo investigation for identifying circular features in the Tusayan Ranger District was conducted to give the U.S. Forest Service site-specific data on areas where possible uranium exploration may take place. The intent was not to identify uranium-mineralized breccia pipes or calculate resources or reserves, but rather to identify circular features which would ultimately need to be field checked and drilled to see if they are indeed breccia pipes. Although circular features do not always denote breccia pipes, they are useful to mining companies in their initial exploration for breccia pipes. The data presented herein are not complete in terms of field checking each circular feature that was identified in the aerial photographs. The data are useful, however, in showing the density and distribution of circular features in the region. This will give the land use planner a tool to aid in further investigating site-specific areas of the Forest.

The initial investigation to identify circular features in the Tusayan Ranger District began with mapping of circular features recognizable on 1:12,000- and 1:24,000-scale color aerial photographs. It should be noted that only certain size features can be recognized at these scales; the throat of the pipe may be 200 ft. in diameter whereas the collapse cone may be up to 0.5 mi. in diameter. Petroleum Information Company of Denver, Colorado, and Bureau/U.S. Geological Survey personnel performed separate examinations and interpretations of the photographs. The physical and geologic characteristics of the Canyon, New Year, and Black Box breccia pipes were used as prototypes to evaluate circular features identified on the aerial photographs. The three above mentioned pipes are characterized by circular areas of soil within a subtle depression surrounded by trees. The New Year pipe is characterized by a closed depression. The Butte NE pipe is characterized by an horseshoe-shaped limestone ridge around a circular depression. Very thin beds of red sandstone dip inward toward the middle of this depression. The Shale pipe is characterized by a distinctive reddish color, probably caused by the down-dropped Moenkopi Sandstone in the pipe.

A total of 495 circular features were identified in the entire Tusayan Ranger District by Petroleum Information (pl. 3, red circles). These circular features may represent either gypsum collapses within the limestone, breccia pipes, or possibly just the topographic expression of normal weathering of the limestone. The Bureau, in cooperation with the U.S.G.S., identified 411 circular features within a portion of the Tusayan Ranger District that includes the Red Butte, Red Butte SW, Tusayan East, and Tusayan West 7 1/2 minute quadrangles (pl. 3, green and blue circles). Some of the circular features were field checked using a helicopter and then ground checked to see which features possess characteristics similar to known breccia pipes.

Of the 411 circular features identified by the Bureau and U.S.G.S., 260 (64%) were field checked. One hundred fifty six of those were determined to be unrelated to breccia pipes (not shown on pl. 3). In other words, of the 260 circular features that were field checked about 104 (40%) possessed surface characteristics of known breccia pipes (green circles on pl. 3). Based on those data, a statistical assumption can be made that approximately 60 of the

151 remaining circular features (blue circles on pl. 3) that were not field checked, may contain characteristics common to known breccia pipes.

Using the Petroleum Information circular feature data and the 40% estimation from the Bureau/U.S.G.S. study, it is reasonable to estimate that about 200 circular features possess surface characteristics of known breccia pipes in the entire Tusayan Ranger District. A fraction of those are probably breccia pipes and a fraction of that total may be mineralized.

Three areas were identified in the Tusayan Ranger District that more strongly exhibited surface characteristics similar to known breccia pipes than other circular features (fig. 11). In area number 1, a very conspicuous, large, circular feature was identified from aerial photographs in T. 28 N., R. 3 E., Sec. 14. The north, east, and south edges of this circular feature are delineated with five smaller (about 500 ft diameter) circular features. Some of these contain red Moenkopi Sandstone, providing a color similar to the color in the Shale and Butte NE pipes. The southernmost of these small features contains Moenkopi Sandstone that dips inward in the feature at 5-7 degrees.

Area two also contains a large circular feature with a low hill and five centripetal drainages. This feature is in T. 29 N., R. 2 E., Sec. 21 and 22. A shallow prospect pit has been dug on the northern edge of this small feature and exposes hematitic breccia with goethite clasts; gamma radiation is about 2 times background. North of this smaller feature is another circular

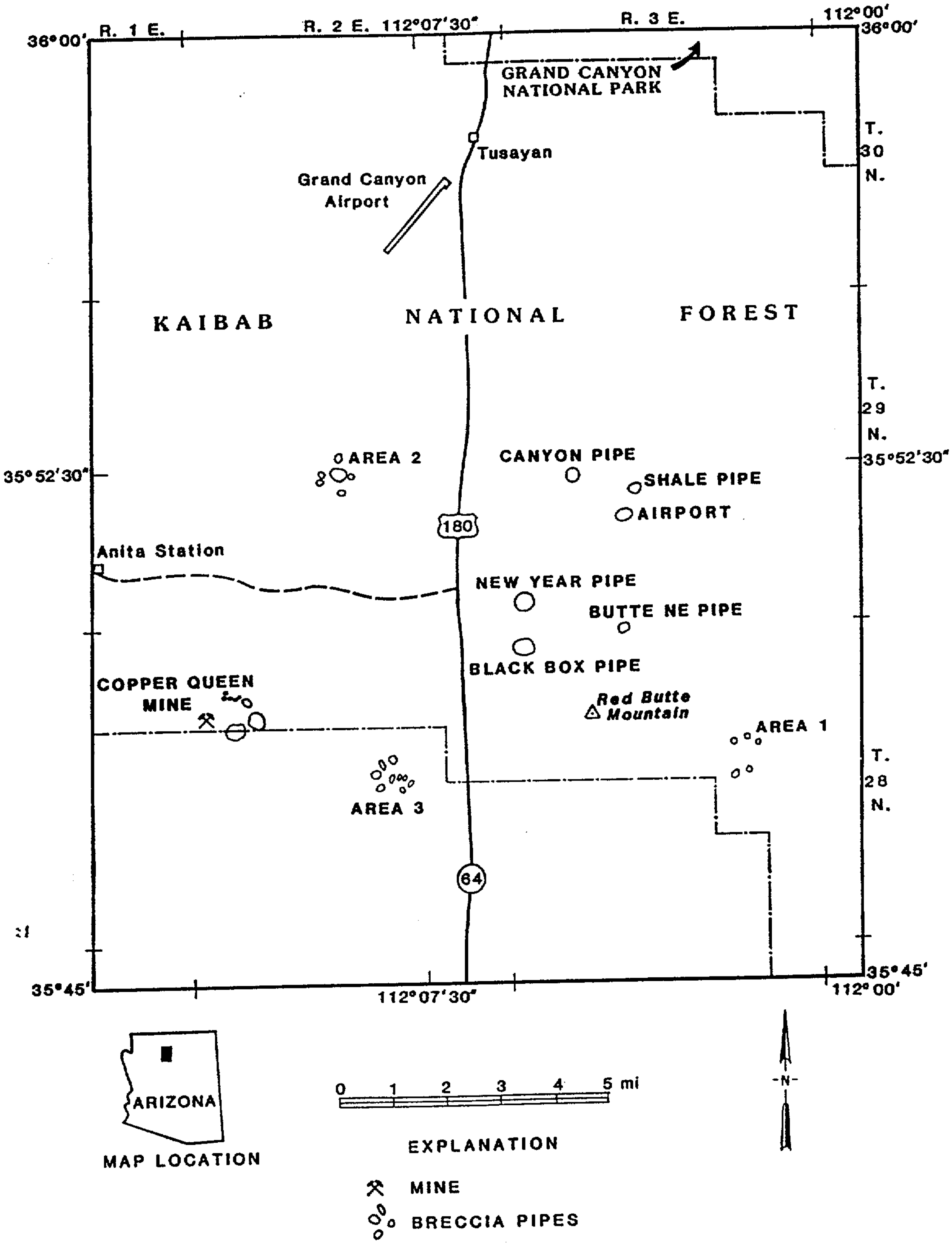



Figure 11. Index map of circular features mapped during the Kaibab National Forest study that exhibit surface features similar to known mineralized breccia pipes.

feature with a prospect pit. Gamma radiation at this location is about 10 times background. A sample of the gossan from this pit contains elevated concentrations of several metals that are characteristic of breccia pipe deposits (tables 1 and 2, sample no. 62; 7,760 ppm As, 760 ppm Co, 222 ppm Mo, 350 ppm Ni, 94 ppm U, and 3,700 ppm Zn). Energy Fuels Nuclear drilled three holes in this area but did not find any breccia pipes.

The third area lies in the corner of sections 14, 15, 22, and 23, T. 28 N., R. 2 E. Six circular features (one a sinkhole) are along the perimeter of a larger circular feature. Three distinct sinkholes have been mapped within the center of a larger feature. Another cluster of sinkholes is northeast of the Copper Queen Mine. These sinkholes occur in an area where dissolution of the limestone and near-surface gypsum has created a localized karst surface.

The circular feature investigation has revealed many localities (pl. 3) with surface characteristics described by Wenrich and Sutphin (1988). Several of these features possess one or more of the same characteristics found at the six known mineralized breccia pipes in the Tusayan Ranger District.

In 1990, the U. S. Geological Survey estimated the undiscovered uranium endowment in solution-collapse breccia pipes in the Grand Canyon region, which includes the Kaibab National Forest. The report concluded that the North Kaibab and Tusayan Ranger Districts are within an area deemed favorable for the occurrence of uranium-bearing breccia pipes. The Chalendar and Williams Ranger Districts are in an area that contains rocks favorable for the occurrence of uranium-bearing breccia pipes; however, the Chalendar and Williams Ranger Districts were considered less favorable than the Tusayan and North Kaibab Ranger Districts because no pipes have been confirmed in these areas and also because of the volcanic cover over the limestones. Another reason for the less favorable rating is that the Redwall Limestone in the Chalendar and Williams Ranger Districts is thinner than a critical thickness (arbitrarily designated as 50 ft), and dissolution then may have been insufficient to have caused stoping and collapse of overlying strata. (See Finch and others, 1987, p. 1-11.)

## Conclusion

The identification of circular features on the land surface is one of the prerequisites to identification of breccia pipes. The Bureau investigation was designed to identify circular features which could at some point in time be field checked if land planners needed site-specific information on possible mineral exploration in the Tusayan Ranger District. Many of these circular features were field-checked and some of them may be breccia pipes. Not all circular features are surface manifestations of breccia pipes; some are simply near-surface gypsum collapses. Mining companies have identified nineteen breccia pipes in the Tusayan Ranger District; ten of those are mineralized.

A total of 495 circular features were identified from aerial photos by Petroleum Information Company. It is estimated that as many as 200 of those features have one or more surface characteristics of known breccia pipes; a small percentage of these probably are actual breccia pipes. Ten mineralized pipes are known to occur within the Tusayan Ranger District. Three areas identified during the Bureau's study exhibit surface characteristics similar to those of mineralized breccia pipes. No matter which surface criteria are used to identify possible pipes, the only way to determine which are mineralized breccia pipes is to drill the site. If the price of uranium increases and anti-uranium mining sentiment decreases, exploration activity, including drilling, could be expected to occur at some of the sites identified on the circular feature plate.

REFERENCES


Ageton, R. W., and Greenspoon, G. N., 1970, Copper, in Mineral facts and Problems, U. S. Bureau of Mines Bulletin 650, p. 535-554.

Bates, R. L., 1983, Introduction, in Lefond, S.J., ed., Industrial minerals and rocks, (5th ed.), Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., New York, New York, v. 1, p. 11.

Billingsley, G. H., 1974, Mining in Grand Canyon, in Breed,W. J., and Roat, E. C., eds, Geology of the Grand Canyon: Museum of Northern Arizona and Grand Canyon Natural History Assoc., p. 170-185.

Billingsley, G. H., 1990, Geologic map of the Jumpup Canyon and Big Springs Quadrangles, Mohave and Coconino Counties, Arizona: Geological Survey Open-File Report 90-258, 15 p., 1 plate, scale 1:62,500.

Billingsley, G. H., Wenrich, K. J., Huntoon, P. W., and Young, R. A., 1986, Breccia pipe and geologic map of the southwestern Hualapai Indian Reservation and vicinity, Arizona: U.S. Geological Survey Open-File Report 86-458D, 33 p., 2 plates, scale 1:48,000.

Billingsley, G. H., Wenrich, K. J., and Huntoon, P. W., 1986, Breccia pipe and geologic map of the southeastern Hualapai Indian Reservation and vicinity, Arizona: U.S. Geological Survey Open-File Report 86-458-B, 26 p., 2 plates, scale 1:48,000.

Boyle, R. W., 1979, The geochemistry of gold and its deposits: Geological Survey of Canada Bulletin 280, 584 p.

Carr, D. D., and Rooney. L. F., 1983, Limestone and dolomite, in Lefond, S. J., ed., Industrial minerals and rocks, (5th ed.), Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., New York, New York, v. 2, p. 833-837.

Chenoweth, W.L., 1986, The Orphan Lode mine, Grand Canyon, Arizona, a case history of a mineralized, collapse-breccia pipe: U.S. Geological Survey Open-File Report 86-510, 126 p.

Emmons, S. F., and Hayes, C. W., 1904, Copper in the Red Beds of the Colorado Plateau region, in U.S. Geological Survey Bulletin 260, p. 221-232.

Finch, W. I., Sutphin, H. B., Pierson, C. T., McCammon, R. B., and Wenrich, K. J., The 1987 estimate of undiscovered uranium endowment in solution-collapse breccia pipes in the Grand Canyon region of northern Arizona and adjacent Utah: U. S. Geological circular 1051, 19 p.

Hoffer, J. M., 1990, Pumice physical properties and the Bill Williams Mountains and Copar Pumices: Hoffer and Hoffer, Consulting Geologists, Unpublished report of pumice sample analyses prepared for the USDA Forest Service, 9 p.

_____, 1991, Pumice and pumicite in New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin, in press.

Keith, S. B., 1969, Sandstone, in Mineral and water resources of Arizona: The Arizona Bureau of Mines Bulletin 180, p. 441-448.

_____, S. B., Gest, D. E., DeWitt, E., Toll, N. W., Everson, B. A., 1983, Metallic mineral districts and production in Arizona: Arizona Bureau of Geology and Mineral Technology Bulletin 194, 58 p.

Krewedl, D. A., and Carisey, Jean-Claude, 1986, Contributions to the geology of uranium mineralized breccia pipes in northern Arizona: Arizona Geological Society Digest, Volume XVI, p. 179-186.

Ludwig, K. R., and Simmons, K. R., 1988, Progress in U/Pb isotope studies of collapse-breccia pipes in the Grand Canyon region, northern Arizona [abs.]: Geological Society of America Abstracts with Programs, v. 20, no. 7, p. A139.

McKee, E. D., and Butschick, R. C., 1969, History of the Redwall Limestone of northern Arizona: Geological Society of America Memoir 114, 692 p.

Moore, R. T., Wilson, E. D., and O'Haire, R. T., 1960, Geologic map of Coconino County, Arizona: Arizona Bureau of Mines, University of Arizona, 1 plate, 1:375,000 scale.

Newhall, G. C., Ulrich, G. E., and Wolfe, E. W., 1987, Geologic map of the southwest part of the San Francisco volcanic field, north-central Arizona: U.S. Geological Survey Miscellaneous Field Studies Map MF-1958 and Pamphlet, scale 1:50,000.

Osburn, J. C., 1979, Evaluation of scoria deposits in New Mexico: New Mexico Bureau of Mines and Mineral Resources Annual Report for the fiscal year July 1, 1978 to June 30, 1979, p. 75-80.

Osburn, J. C., 1982, Scoria exploration and utilization in New Mexico, in Austin, G. S., ed., Industrial rocks and minerals of the Southwest, New Mexico Bureau of Mines and Mineral Resources Circular 182, p. 57-59.

Peterson, N. V., and Mason, R. S., 1983, Pumice, pumicite, and volcanic cinders, in Lefond, S. J., ed., Industrial minerals and rocks, (5th ed.), Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc,. New York, New York, v. 2, p. 1079-1084.

Reid, A.R., and Rasmussen, J.D., 1990, The use of soil-gas $CO_2$ in the exploration for sulfide-bearing breccia pipes in northern Arizona: Journal of Geochemical Exploration, v. 38, nos. 1/2, p. 87-101.

Strathy, R., 1990, Chem-Stone mineral material classification report, Deadeye and Sue Claims: USDA, Forest Service Mineral Report, Southwest Region, Albuquerque, New Mexico, 17 p. and appendices.

Sutphin, H.B., and Wenrich, K.J., 1989, Map locations of collapse-breccia pipes in the Grand Canyon of Arizona: U.S. Geological Survey Open-File Report 89-550, 1 plate, scale 1:250,000.

Tainter, Stanton L., 1947, Apex copper property, Coconino County Arizona: U.S. Bureau of Mines Report of Investigations 4013, 9 p.

Tourtelot, E. B., and Vine, J. D., 1976, Copper deposits in sedimentary and volcanogenic rocks: U.S. Geological Survey Professional Paper 907-C, 34 p.

Van Gosen, B. S., 1989, Geochemistry and genesis of stratabound copper deposits in the Kaibab Limestone, Coconino County, northern Arizona: Proposed research in partial fulfillment of the Master of Science degree in geology at the Colorado School of Mines, Golden, Colorado, 27 p.

_____, and Wenrich, K. J., 1989, Ground magnetometer surveys over known and suspected breccia pipes on the Coconino Plateau, northwestern Arizona: U.S. Geological Survey Bulletin 1683-C, 31 p.

Wenrich, K. J. and Almquist, C. L., Breccia Pipes in the Red Butte area of Kaibab National Forest, Arizona: U.S. Geological Survey Open File Report 92-219, unpublished, 14 p.

Wenrich, K. J., Billingsley, G. H., and Van Gosen, B. S., 1990, Potential breccia pipes in the Mohawk Canyon Area, Hualapai Indian Reservation, Arizona: U. S. Geological Survey Open File Report 90-5, 67 p.

_____, K. J., Chenoweth, W. L., Finch, W. I., and Scarborough, R. B., 1989, Uranium in Arizona, in Jenney, J.P., and Reynolds, S. J., eds., Geologic evolution of Arizona: Arizona Geological Society Digest 17, p. 759-794.

_____, K.J., and Sutphin, H.B., 1988, Recognition of breccia pipes in northern Arizona, in Fieldnotes: Tucson, Arizona, Arizona Bureau of Mines and Mineral Technology, v. 18, no. 1, p. 1-5, 11.

_____, 1987, Breccia pipe and geologic map of the northwestern Hualapai Indian Reservation and vicinity, Arizona: U.S. Geological Survey Open-File Report 86-458-C, 32 p., 2 plates, scale 1:48,000 (to be later released in the I-map series).

_____, Billingsley, G. H., and Huntoon, P. W., 1986, Breccia pipe and geologic map of the northeastern Hualapai Indian Reservation and vicinity, Arizona: U.S. Geological Survey Open-File Report 86-458-A, 29 p., 2 plates, scale 1:48,000 (to be later released in the I-map series).

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.

[Select, high grade of rock chips; ---, not applicable.]

| Sample | | | | |
|---|---|---|---|---|
| No. | Type | length (ft) | Location | Description |
| 1 | Chip | 4.7 | North Kaibab Ranger District; T. 38 N., R. 1 E., sec. 1. | Prospect pit; azurite, limonite, and malachite stain on fracture surfaces and bedding planes in brecciated limestone. |
| 2 | do. | 2.0 | do. | do. |
| 3 | Select | --- | do. | do. |
| 4 | Chip | 2.5 | do. | Prospect pit; iron oxide-stained, brecciated limestone with traces of malachite stain. |
| 5 | do. | 3.0 | do. | Prospect pit; limonite-stained, vuggy, silicified limestone, no malachite stain. |
| 6 | Select | --- | do. | Prospect pit; limonite-stained fragments of limestone and chert. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample | | | | |
| --- | --- | --- | --- | --- |
| No. | Type | length (ft) | Location | Description |
| 7 | Chip | 7.2 | North Kaibab Ranger District; T. 38 N., R. 1E., sec. 13. | Lambs Lake pit; azurite, limonite, and malachite stain on brecciated, cherty, limestone. |
| 8 | do. | 1.4 | do. | Lambs Lake pit; azurite, limonite, and malachite stain on brecciated, silicified, limestone. |
| 9 | do. | 2.0 | do. | do. |
| 10 | do. | 8.0 | do. | do. |
| 11 | do. | 4.0 | do. | do. |
| 12 | do. | 2.0 | do. | do. |
| 13 | do. | 3.0 | do. | do. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample | | | | |
|---|---|---|---|---|
| No. | Type | length (ft) | Location | Description |
| 14 | Chip | 3.2 | North Kaibab Ranger District; T. 38 N., R. 1E., sec. 13. | Lambs Lake pit; azurite, limonite, and malachite stain on brecciated, silicified, limestone. |
| 15 | do. | 2.0 | do. | do. |
| 16 | do. | 10 | do. | Lambs Lake pit; azurite, limonite, and malachite stain on fracture surfaces and bedding planes of silicified and brecciated limestone. |
| 17 | do. | 4.6 | do. | do. |
| 18 | do. | 2.0 | do. | Prospect pit near Lambs Lake pit; azurite, limonite, and malachite stain on fracture surfaces and bedding planes of silicified and brecciated limestone. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 19 | Chip | 1.3 | North Kaibab Ranger District; T. 38 N., R. 1E., sec. 13. | 120-ft-long trench near Lambs Lake pit; azurite, limonite, and malachite stain on fracture surfaces and bedding planes in silicified, brecciated limestone. |
| 20 | Select | --- | do. | do. |
| 21 | do. | --- | North Kaibab Ranger District; T. 38 N., R. 1 E., sec. 12. | 350-ft-long trench; high-grade sample of azurite- and malachite-stained limestone chips, some gossan-like material. |
| 22 | Chip | 1.0 | do. | 450-ft-long trench; azurite-, limonite-, and malachite-stained, silicified, brecciated limestone. |
| 23 | do. | 3.0 | do. | 400-ft-long trench; same description as no. 22. |
| 24 | Select | --- | do. | Prospect pit; same description as no. 22. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 25 | Chip | 3.8 | North Kaibab Ranger District; T. 38 N., R. 1 E., sec. 12. | 100-ft-long trench; same description as no. 22. |
| 26 | do. | 6.0 | Tusayan Ranger District; T. 29 N., R. 6 E., sec. 4. | 30-ft-long prospect pit; red shale zone, no obvious mineralization. |
| 27 | Select | --- | Tusayan Ranger District; T. 30 N., R. 6 E., sec. 4. | Patented Highland Mary claim; azurite-, limonite-, and malachite-stained, silicified, brecciated limestone. |
| 28 | Chip | 2.5 | Tusayan Ranger District; T. 30 N., R. 2 E., sec. 8. | North-east-trending, 35-ft-long adit; azurite-, limonite-, and malachite-stained, silicified, brecciated, chert and limestone. |
| 29 | do. | 1.0 | do. | Prospect pit near no. 28; same sample description. |

Table 1.--<u>Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.</u>--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample | | | | |
|---|---|---|---|---|
| No. | Type | length (ft) | Location | Description |
| 30 | Select | --- | Tusayan Ranger District; T. 30 N., R. 2 E., sec. 17. | Prospect pit; chalcopyrite, malachite stain on brecciated, silicified, limestone and chert. |
| 31 | do. | --- | do. | Prospect pit; same sample description as no. 30. |
| 32 | Chip | 2.0 | Tusayan Ranger District; T. 30 N., R. 2 E., sec. 20. | Prospect pit; azurite-, limonite-, and malachite-stained, silicified, brecciated limestone and chert. |
| 33 | Select | --- | do. | Prospect pit; limonite-stained limestone and chert. |
| 34 | do. | --- | do. | Prospect pit; malachite-stained, brecciated, limestone. |
| 35 | do. | --- | do. | do. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample | | | | |
|---|---|---|---|---|
| No. | Type | length (ft) | Location | Description |
| 36 | Chip | 2.8 | Tusayan Ranger District; T. 30 N., R. 2 E., sec. 29. | Prospect pit; same sample description as no. 35. |
| 37 | do. | 4.0 | do. | Prospect pit; azurite-, limonite- and malachite-stained, limestone. |
| 38 | do. | 2.0 | do. | do. |
| 39 | do. | 2.0 | do. | do. |
| 40 | do. | 2.0 | do. | Adit; iron-oxide-stained gouge and malachite-stained limestone. |
| 41 | do. | 1.5 | do. | Same adit as no. 40; iron-oxide-stained gouge, azurite and malachite stain on limestone fragments in NE-trending fault. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample | | | | |
|---|---|---|---|---|
| No. | Type | length (ft) | Location | Description |
| 42 | Chip | 1.0 | Tusayan Ranger District; T. 30 N., R. 2 E., sec. 29. | Same adit as no. 40; same description as no. 41, but different fault. |
| 43 | do. | 3.2 | do. | Same adit as no. 40; sample is from face of adit; calcite and iron oxides cementing limestone fragments. |
| 44 | Select | --- | Tusayan Ranger District; T. 30 N., R. 2 E., sec. 33. | Prospect pit; no minerals observed at this location. |
| 45 | do. | --- | Tusayan Ranger District; T. 30 N., R. 2 E., sec. 32. | Dump of reclaimed shaft; iron-oxide-stained limestone, some gossan-like material, minor azurite and malachite stain. |
| 46 | do. | --- | do. | Dump of reclaimed shaft; iron-oxide-stained limestone, minor azurite and malachite stain. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Type | length (ft) | Location | Description |
|---|---|---|---|---|
| 47 | Select | --- | Tusayan Ranger District; T. 29 N., R. 3 E., sec. 1. | Sample consists of chips of manganese-stained limestone. |
| 48 | do. | --- | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 17. | Prospect pit; minor malachite stain on limestone. |
| 49 | do. | --- | do. | Prospect pit; minor limonite and malachite stain on limestone fragments. |
| 50 | Chip | 1.3 | do. | Prospect pit; minor limonite and malachite stringers in limestone. |
| 51 | do. | 3.5 | do. | Prospect pit; minor limonite and malachite stain on limestone fragments. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample | | | | |
| --- | --- | --- | --- | --- |
| No. | Type | length (ft) | Location | Description |
| 52 | Select | --- | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 17. | Prospect pit; abundant calcite with specks of malachite; limestone. |
| 53 | Select | --- | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 16. | Prospect pit; small calcite crystals on limestone with minor malachite stain. |
| 54 | Chip | 3.0 | do. | Trench; one of two samples from this trench; limonite- and malachite-stained, brecciated, limestone. |
| 55 | do. | 3.0 | do. | do. |
| 56 | Chip | 1.2 | do. | Prospect pit; limonite- and malachite-stained, brecciated, limestone. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 57 | Select | --- | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 17. | Prospect pit; calcite, limonite- and malachite-stained, brecciated limestone. |
| 58 | Select | --- | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 16. | Prospect pit; calcite, chalcopyrite, in malachite-stained limestone. |
| 59 | Chip | 2.0 | do. | 50-ft-long adit; no structure visible; hematite and malachite veinlets in limestone. |
| 60 | Select | --- | do. | Prospect pit; fragments of gossan-like material, minor silicification in limestone. |
| 61 | Chip | 4.0 | do. | Prospect pit; limonite-stained gossan-like material. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Type | length (ft) | Location | Description |
|---|---|---|---|---|
| 62 | Chip | 1.5 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 21. | Prospect pit; gossan-like material in brecciated, and vuggy limestone. |
| 63 | do. | 1.3 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 22. | Prospect pit; gossan-like, vuggy material in limestone country rock. Spectrometer background of 20 cps, 54 cps in pit. |
| 64 | do. | 2.5 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 20. | Prospect pit; minor limonite and malachite stain on brecciated limestone fragments. |
| 65 | do. | 2.4 | do. | Caved adit; sample from portal; malachite-stained, brecciated, limestone. |
| 66 | Select | --- | do. | Prospect pit; limonite- and malachite-stained, brecciated limestone. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 67 | Chip | --- | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 20. | Trench; limonite- and malachite-stained, brecciated limestone. |
| 68 | do. | 3.5 | do. | do. |
| 69 | Chip | 2.0 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 20. | Caved adit; chalcopyrite, malachite-stained limestone. |
| 70 | do. | 3.3 | do. | Prospect pit; iron-oxide-stained limestone. |
| 71 | Select | --- | do. | Prospect pit; chalcopyrite, azurite-, limonite-, and malachite-stained, brecciated limestone. |
| 72 | Chip | 3.0 | do. | One of two samples from a 280-ft-long trench; abundant limonite and malachite stain on brecciated limestone. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 73 | Chip | 2.0 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 20. | One of two samples from a 280-ft-long trench; abundant limonite and malachite stain on brecciated limestone. |
| 74 | do. | 3.2 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 29. | 10-ft-long adit; sample from portal; tiny blebs and stringers of limonite and malachite in brecciated limestone. |
| 75 | Chip | 6.7 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 29. | 150-ft-long trench; limonite and malachite stain, blebs, and stringers, in brecciated, silicified, limestone. |
| 76 | do. | 2.0 | do. | Same trench as no. 75; limonite and malachite stain, blebs, and stringers, in brecciated, silicified, limestone. |
| 77 | do. | 3.3 | do. | do. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample | | | | |
|---|---|---|---|---|
| No. | Type | length (ft) | Location | Description |
| 78 | Select | --- | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 29. | 540-ft-deep shaft; sample is from dump, gypsum, minor malachite stain on limestone. |
| 79 | Chip | 2.3 | do. | Prospect pit; limonite- and malachite-stained, brecciated, silicified, limestone. |
| 80 | do. | 2.0 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 29. | Prospect pit; chalcopyrite, limonite- and malachite-stained, brecciated, silicified limestone. |
| 81 | Chip | 2.7 | do. | Prospect pit; limonite- and malachite-stained, brecciated, limestone. |
| 82 | do. | 3.8 | do. | Prospect pit; azurite-, limonite-, and malachite-stained brecciated, silicified, limestone. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 83 | Chip | 4.0 | Tusayan Ranger District; T. 29 N., R. 2 E., sec. 29. | 25-ft-deep shaft; limonite boxwork in limestone, some gossan-like material. |
| 84 | do. | 3.3 | Tusayan Ranger District; T. 28 N., R. 2 E., sec. 7. | Copper Queen Mine area; limonite and malachite stain on brecciated limestone fragments, possible chalcocite. |
| 85 | Select | --- | do. | do. |
| 86 | Chip | 5.0 | Tusayan Ranger District; T. 28 N., R. 2 E., sec. 7. | do. |
| 87 | do. | 5.0 | do. | do. |
| 88 | Chip | 5.0 | do. | do. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 89 | Chip | 2.3 | Tusayan Ranger District; T. 28 N., R. 2 E., sec. 7. | Copper Queen Mine area; limonite and malachite stain on brecciated limestone fragments, possible chalcocite. |
| 90 | Select | --- | Tusayan Ranger District; T. 28 N., R. 2 E., sec. 1. | Prospect pit; minor limonite and malachite stain on brecciated limestone fragments. |
| 91 | do. | --- | do. | Prospect pit; minor limonite and malachite stain on limestone, calcite. |
| 92 | do. | --- | Chalendar Ranger District; T. 25 N., R. 5 E., sec. 7. | Black scoriaceous cinder. |
| 93 | do. | --- | Chalendar Ranger District; T. 25 N., R. 4 E., sec. 11. | do. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 94 | Select | --- | Chalendar Ranger District; T. 25 N., R. 4 E., sec. 21. | Black scoriaceous cinder. |
| 95 | do. | --- | do. | Gray to black scoriaceous cinder. |
| 96 | do. | --- | Chalendar Ranger District; T. 25 N., R. 3 E., sec. 19. | Red scoriaceous cinder. |
| 97 | do. | --- | Chalendar Ranger District; T. 24 N., R. 4 E., sec. 2. | do. |
| 98 | do. | --- | Chalendar Ranger District; T. 24 N., R. 4 E., sec. 5. | do. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 99 | Select | --- | Chalendar Ranger District; T. 24 N., R. 3 E., sec. 1. | Black basalt. |
| 100 | do. | --- | Chalendar Ranger District; T. 25 N., R. 3 E., sec. 36. | Red scoriaceous cinder and black basalt. |
| 101 | do. | --- | do. | Black, dense basalt. |
| 102 | do. | --- | do. | Gray to black scoriaceous cinder. |
| 103 | Select | --- | Chalendar Ranger District; T. 24 N., R. 3 E., sec. 32. | Black, dense basalt. |
| 104 | do. | --- | Chalendar Ranger District; T. 24 N., R. 3 E., sec. 30. | Black, dense basalt. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 105 | Chip | --- | Chalendar Ranger District; T. 22 N., R. 2 E., sec. 22. | Black scoriaceous cinder. |
| 106 | do. | --- | do. | do. |
| 107 | do. | --- | do. | Black scoriaceous cinder. |
| 108 | do. | --- | do. | do. |
| 109 | Select | --- | Chalendar Ranger District; T. 22 N., R. 1 E., sec. 11. | Red scoriaceous cinder. |
| 110 | do. | --- | Chalendar Ranger District; T. 23 N., R. 2 W., sec. 8. | do. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 111 | Chip | --- | Chalendar Ranger District; T. 23 N., R. 2 W., sec. 8. | Red scoriaceous cinder. |
| 112 | do. | --- | Chalendar Ranger District; T. 23 N., R. 2 W., sec. 8. | do. |
| 113 | do. | ___ | do. | Red scoriaceous cinder. |
| 114 | do. | --- | Chalendar Ranger District; T. 20 N., R. 2 W., sec. 15. | Red scoriaceous cinder. |
| 115 | Select | --- | Chalendar Ranger District; T. 24 N., R. 3 E., sec. 32. | Re-analysis of sample no. 103. |

Table 1.--Description of rock samples from the Kaibab National Forest, Coconino County, Ariz.--Continued

[Select, high grade of rock chips; ---, not applicable.]

| Sample No. | Sample Type | Sample length (ft) | Location | Description |
|---|---|---|---|---|
| 116 | Select | --- | Chalendar Ranger District; T. 22 N., R. 2 E., sec. 22. | Re-analysis of sample no. 105. |
| 117 | do. | --- | Chalendar Ranger District; T. 23 N., R. 2 W., sec. 8. | Re-analysis of sample no. 111. |

Table 2.--Analytical data for samples collected during the Kaibab National Forest study.

[BC-INA, Bondar-Clegg Instrument Neutron Activation; BC-AA, Bondar-Clegg Atomic Absorption; BC-FA/AA, Bondar-Clegg Fire Assay/Atomic Absorption Spectroscopy finish; BC-DCPE, Bondar-Clegg Direct Coupled Plasma Emission; CX-ICP, Chemex Inductively Coupled Plasma Spectrometry; CX-FA/AA, Chemex Fire Assay/Atomic Absorption Spectroscopy finish; ---, not applicable.]

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | --- | --- | 945 | --- | <5 | --- | --- | 160 |
| 2 | 24 | --- | --- | 1210 | --- | <5 | --- | --- | <100 |
| 3 | 8 | --- | --- | 545 | --- | <5 | --- | --- | <100 |
| 4 | 14 | --- | --- | 611 | --- | <5 | --- | --- | <100 |
| 5 | 7 | --- | --- | 385 | --- | <5 | --- | --- | <100 |
| 6 | <5 | --- | --- | 13 | --- | <5 | --- | --- | 230 |
| 7 | <5 | --- | --- | 255 | --- | <5 | --- | --- | <100 |
| 8 | <5 | --- | --- | 184 | --- | <5 | --- | --- | <100 |
| 9 | 7 | --- | --- | 111 | --- | <5 | --- | --- | <100 |
| 10 | <5 | --- | --- | 76 | --- | <5 | --- | --- | <100 |
| 11 | 12 | --- | --- | 1690 | --- | <5 | --- | --- | <100 |
| 12 | 9 | --- | --- | 4520 | --- | <21 | --- | --- | <100 |
| 13 | <5 | --- | --- | 299 | --- | <5 | --- | --- | <100 |
| 14 | <5 | --- | --- | 27 | --- | <5 | --- | --- | <100 |
| 15 | <5 | --- | --- | 1040 | --- | <5 | --- | --- | <100 |
| 16 | 7 | --- | --- | 572 | --- | <5 | --- | --- | <100 |
| 17 | 13 | --- | --- | 245 | --- | <5 | --- | --- | <100 |
| 18 | <5 | --- | --- | 369 | --- | 6 | --- | --- | <100 |
| 19 | <5 | --- | --- | 34 | --- | 5 | --- | --- | <100 |
| 20 | 9 | --- | --- | 1130 | --- | <5 | --- | --- | <100 |
| 21 | 10 | --- | --- | 1780 | --- | <5 | --- | --- | 200 |
| 22 | 7 | --- | --- | 648 | --- | <5 | --- | --- | 190 |
| 23 | 9 | --- | --- | 245 | --- | 7 | --- | --- | <100 |
| 24 | <5 | --- | --- | 1960 | --- | <11 | --- | --- | <100 |
| 25 | <5 | --- | --- | 342 | --- | <5 | --- | --- | <100 |
| 26 | <5 | --- | --- | 14 | --- | <5 | --- | --- | 210 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 27 | 17 | --- | --- | 551 | --- | <5 | --- | --- | <100 |
| 28 | <5 | --- | --- | 150 | --- | 7 | --- | --- | <100 |
| 29 | 6 | --- | --- | 813 | --- | <5 | --- | --- | <260 |
| 30 | 9 | --- | --- | 183 | --- | 16 | --- | --- | <100 |
| 31 | <5 | --- | --- | 12 | --- | <5 | --- | --- | <100 |
| 32 | <5 | --- | --- | 12 | --- | <5 | --- | --- | <100 |
| 33 | <5 | --- | --- | 5 | --- | <5 | --- | --- | <100 |
| 34 | <5 | --- | --- | 53 | --- | 8 | --- | --- | <100 |
| 35 | <5 | --- | --- | 158 | --- | <5 | --- | --- | <100 |
| 36 | <5 | --- | --- | 5480 | --- | <17 | --- | --- | <210 |
| 37 | <5 | --- | --- | 3670 | --- | <13 | --- | --- | <100 |
| 38 | <5 | --- | --- | 821 | --- | <5 | --- | --- | <100 |
| 39 | <5 | --- | --- | 900 | --- | 13 | --- | --- | <100 |
| 40 | <5 | --- | --- | 5070 | --- | <15 | --- | --- | <100 |
| 41 | <5 | --- | --- | 690 | --- | <5 | --- | --- | <100 |
| 42 | <5 | --- | --- | 1620 | --- | <5 | --- | --- | <100 |
| 43 | <5 | --- | --- | 345 | --- | <5 | --- | --- | <100 |
| 44 | <5 | --- | --- | 67 | --- | <5 | --- | --- | 250 |
| 45 | <5 | --- | --- | 6540 | --- | 45 | --- | --- | <470 |
| 46 | <5 | --- | --- | 1710 | --- | <5 | --- | --- | <100 |
| 47 | <5 | --- | --- | 6 | --- | <5 | --- | --- | 450 |
| 48 | <5 | --- | --- | 24 | --- | <5 | --- | --- | <100 |
| 49 | <5 | --- | --- | 37 | --- | <5 | --- | --- | <100 |
| 50 | <5 | --- | --- | 17 | --- | <5 | --- | --- | 340 |
| 51 | <5 | --- | --- | 36 | --- | 8 | --- | --- | <100 |
| 52 | <5 | --- | --- | 42 | --- | <5 | --- | --- | <100 |
| 53 | 8 | --- | --- | 118 | --- | 6 | --- | --- | <100 |
| 54 | 10 | --- | --- | 325 | --- | <5 | --- | --- | 1300 |
| 55 | <5 | --- | --- | 69 | --- | <5 | --- | --- | 760 |
| 56 | >50 | --- | --- | 388 | --- | 21 | --- | --- | <100 |
| 57 | <5 | --- | --- | 52 | --- | 5 | --- | --- | <100 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 58 | 17 | --- | --- | 537 | --- | 12 | --- | --- | <100 |
| 59 | >50 | --- | --- | 590 | --- | 36 | --- | --- | <100 |
| 60 | <5 | --- | --- | >10000 | --- | <14 | --- | --- | <100 |
| 61 | <5 | --- | --- | 3980 | --- | <12 | --- | --- | <100 |
| 62 | <5 | --- | --- | 7760 | --- | <12 | --- | --- | <310 |
| 63 | <5 | --- | --- | >10000 | --- | <29 | --- | --- | <100 |
| 64 | <5 | --- | --- | 167 | --- | <5 | --- | --- | <100 |
| 65 | <5 | --- | --- | 394 | --- | 6 | --- | --- | <100 |
| 66 | <5 | --- | --- | 159 | --- | <5 | --- | --- | 680 |
| 67 | <5 | --- | --- | 44 | --- | <5 | --- | --- | <100 |
| 68 | 6 | --- | --- | 113 | --- | <5 | --- | --- | <100 |
| 69 | 24 | --- | --- | 381 | --- | 7 | --- | --- | <100 |
| 70 | 16 | --- | --- | 529 | --- | <5 | --- | --- | <100 |
| 71 | >50 | --- | --- | 4290 | --- | <5 | --- | --- | <500 |
| 72 | 39 | --- | --- | 215 | --- | <5 | --- | --- | <100 |
| 73 | 12 | --- | --- | 229 | --- | <5 | --- | --- | <100 |
| 74 | <5 | --- | --- | 25 | --- | <5 | --- | --- | <100 |
| 75 | <5 | --- | --- | 407 | --- | <10 | --- | --- | <770 |
| 76 | <5 | --- | --- | 388 | --- | <5 | --- | --- | <100 |
| 77 | <5 | --- | --- | 776 | --- | <5 | --- | --- | <100 |
| 78 | <5 | --- | --- | 8 | --- | <5 | --- | --- | 190 |
| 79 | <5 | --- | --- | 51 | --- | <5 | --- | --- | <100 |
| 80 | 14 | --- | --- | 240 | --- | <5 | --- | --- | <100 |
| 81 | <5 | --- | --- | 214 | --- | <5 | --- | --- | <100 |
| 82 | <5 | --- | --- | 449 | --- | <5 | --- | --- | <100 |
| 83 | <5 | --- | --- | 1040 | --- | <5 | --- | --- | <100 |
| 84 | <5 | --- | --- | 1000 | --- | <5 | --- | --- | <100 |
| 85 | <5 | --- | --- | 413 | --- | <5 | --- | --- | <100 |
| 86 | 7 | --- | --- | 735 | --- | <16 | --- | --- | 200 |
| 87 | <5 | --- | --- | 1910 | --- | <5 | --- | --- | <100 |
| 88 | <5 | --- | --- | 269 | --- | <5 | --- | --- | <100 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 89 | <5 | --- | --- | 126 | --- | <5 | --- | --- | <100 |
| 90 | <5 | --- | --- | 7 | --- | <5 | --- | --- | <100 |
| 91 | <5 | --- | --- | 4 | --- | <5 | --- | --- | <100 |
| 92 | <5 | --- | --- | 4 | --- | <5 | --- | <5 | 610 |
| 93 | <5 | --- | --- | <1 | --- | <5 | --- | <5 | 650 |
| 94 | <5 | --- | --- | 5 | --- | <5 | --- | <5 | 880 |
| 95 | 5 | --- | --- | 4 | --- | <5 | --- | <5 | 830 |
| 96 | <5 | --- | --- | 4 | --- | <5 | --- | <5 | 800 |
| 97 | <5 | --- | --- | 3 | --- | <5 | --- | <5 | 1300 |
| 98 | <5 | --- | --- | 3 | --- | <5 | --- | <5 | 740 |
| 99 | <5 | --- | --- | 2 | --- | <5 | --- | <5 | 1600 |
| 100 | <5 | --- | --- | 3 | --- | <5 | --- | <5 | 770 |
| 101 | <5 | --- | --- | 2 | --- | <5 | --- | <5 | 1000 |
| 102 | <5 | --- | --- | 2 | --- | <5 | --- | <5 | 1400 |
| 103 | <5 | --- | --- | 9 | --- | 9 | --- | <5 | 530 |
| 104 | <5 | --- | --- | 17 | --- | <5 | --- | <5 | 1100 |
| 105 | <5 | --- | --- | 9820 | --- | <17 | --- | 20 | 140 |
| 106 | <5 | 0.6 | 1.32 | 2 | 35 | <5 | <5 | --- | 460 |
| 107 | <5 | 1.0 | 1.73 | 2 | 40 | <5 | <5 | --- | 370 |
| 108 | <5 | 1.8 | 2.65 | <1 | 10 | <5 | 10 | --- | 470 |
| 109 | <5 | --- | --- | 1 | --- | <5 | --- | 5 | 1400 |
| 110 | <5 | --- | --- | 1 | --- | <5 | --- | <5 | 1100 |
| 111 | <5 | --- | --- | 2 | --- | 14 | --- | 10 | 740 |
| 112 | <5 | 1.4 | 2.52 | 1 | 30 | <5 | <5 | --- | 770 |
| 113 | <5 | 0.4 | 1.01 | 1 | 10 | <5 | <5 | --- | 850 |
| 114 | <5 | --- | --- | 2 | --- | <5 | --- | <5 | 660 |
| 115 | <5 | <0.2 | 1.54 | 2 | 5 | <5 | <5 | --- | 750 |
| 116 | <5 | 0.6 | 1.26 | 9 | 30 | <5 | <5 | --- | 700 |
| 117 | <5 | 0.6 | 1.71 | 1 | 40 | <5 | <5 | --- | 700 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | --- | --- | --- | 4 | --- | <10 | --- | <10 | 32 |
| 2 | --- | --- | --- | 7 | --- | <10 | --- | <10 | 540 |
| 3 | --- | --- | --- | 4 | --- | <10 | --- | <10 | 19 |
| 4 | --- | --- | --- | 4 | --- | <10 | --- | <10 | 20 |
| 5 | --- | --- | --- | 2 | --- | <10 | --- | 13 | 20 |
| 6 | --- | --- | --- | 9 | --- | <10 | --- | 12 | <10 |
| 7 | --- | --- | --- | 2 | --- | <10 | --- | <10 | 67 |
| 8 | --- | --- | --- | 2 | --- | <10 | --- | <10 | 36 |
| 9 | --- | --- | --- | 2 | --- | <10 | --- | <10 | 2420 |
| 10 | --- | --- | --- | <1 | --- | <10 | --- | <10 | 560 |
| 11 | --- | --- | --- | 8 | --- | <10 | --- | 22 | 29 |
| 12 | --- | --- | --- | 23 | --- | 31 | --- | <10 | 310 |
| 13 | --- | --- | --- | <1 | --- | <10 | --- | 11 | 120 |
| 14 | --- | --- | --- | <1 | --- | <10 | --- | 10 | 18 |
| 15 | --- | --- | --- | 4 | --- | <10 | --- | <10 | 110 |
| 16 | --- | --- | --- | 4 | --- | <10 | --- | <10 | 83 |
| 17 | --- | --- | --- | 3 | --- | <10 | --- | 21 | 62 |
| 18 | --- | --- | --- | 2 | --- | <10 | --- | <10 | 470 |
| 19 | --- | --- | --- | <1 | --- | <10 | --- | 11 | 45 |
| 20 | --- | --- | --- | 5 | --- | <10 | --- | <10 | 24 |
| 21 | --- | --- | --- | 8 | --- | <10 | --- | <10 | 71 |
| 22 | --- | --- | --- | 4 | --- | <10 | --- | <10 | 15 |
| 23 | --- | --- | --- | 1 | --- | <10 | --- | 23 | 79 |
| 24 | --- | --- | --- | 9 | --- | <10 | --- | <34 | 560 |
| 25 | --- | --- | --- | 3 | --- | <10 | --- | <10 | 320 |
| 26 | --- | --- | --- | 3 | --- | <10 | --- | 19 | <10 |
| 27 | --- | --- | --- | 8 | --- | <10 | --- | <10 | <10 |
| 28 | --- | --- | --- | 2 | --- | <10 | --- | <10 | 15 |
| 29 | --- | --- | --- | 5 | --- | <10 | --- | <10 | 12 |
| 30 | --- | --- | --- | 3 | --- | <10 | --- | <10 | <10 |
| 31 | --- | --- | --- | <1 | --- | <10 | --- | 16 | <10 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 32 | --- | --- | --- | <1 | --- | <10 | --- | <10 | <10 |
| 33 | --- | --- | --- | <1 | --- | <10 | --- | <10 | <10 |
| 34 | --- | --- | --- | <1 | --- | <10 | --- | <10 | <10 |
| 35 | --- | --- | --- | 3 | --- | <10 | --- | <10 | 10 |
| 36 | --- | --- | --- | 49 | --- | 25 | --- | <51 | 13 |
| 37 | --- | --- | --- | 35 | --- | <10 | --- | <39 | 120 |
| 38 | --- | --- | --- | 18 | --- | <10 | --- | <10 | 30 |
| 39 | --- | --- | --- | 23 | --- | <10 | --- | <31 | 40 |
| 40 | --- | --- | --- | 50 | --- | <10 | --- | <46 | 25 |
| 41 | --- | --- | --- | 8 | --- | <10 | --- | <10 | <10 |
| 42 | --- | --- | --- | 17 | --- | <10 | --- | <22 | 16 |
| 43 | --- | --- | --- | 28 | --- | <10 | --- | 20 | 14 |
| 44 | --- | --- | --- | <1 | --- | <10 | --- | 35 | <10 |
| 45 | --- | --- | --- | 51 | --- | 32 | --- | <50 | 390 |
| 46 | --- | --- | --- | 16 | --- | <10 | --- | <25 | 65 |
| 47 | --- | --- | --- | <1 | --- | <10 | --- | 79 | 43 |
| 48 | --- | --- | --- | 4 | --- | <10 | --- | <10 | <10 |
| 49 | --- | --- | --- | 5 | --- | <10 | --- | <10 | <10 |
| 50 | --- | --- | --- | 5 | --- | <10 | --- | <10 | <10 |
| 51 | --- | --- | --- | 5 | --- | <10 | --- | <10 | <10 |
| 52 | --- | --- | --- | 3 | --- | <10 | --- | <10 | <10 |
| 53 | --- | --- | --- | 9 | --- | <10 | --- | <10 | <10 |
| 54 | --- | --- | --- | 10 | --- | <10 | --- | <10 | <10 |
| 55 | --- | --- | --- | 7 | --- | <10 | --- | 13 | <10 |
| 56 | --- | --- | --- | 9 | --- | <10 | --- | <10 | 32 |
| 57 | --- | --- | --- | 4 | --- | <10 | --- | <10 | 11 |
| 58 | --- | --- | --- | 13 | --- | <10 | --- | <10 | 28 |
| 59 | --- | --- | --- | 25 | --- | <10 | --- | <24 | 52 |
| 60 | --- | --- | --- | 65 | --- | <10 | --- | <39 | 790 |
| 61 | --- | --- | --- | 33 | --- | <10 | --- | <35 | 100 |
| 62 | --- | --- | --- | 56 | --- | <10 | --- | <35 | 760 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 63 | --- | --- | --- | 43 | --- | <36 | --- | <32 | 740 |
| 64 | --- | --- | --- | 8 | --- | <10 | --- | 14 | <10 |
| 65 | --- | --- | --- | 12 | --- | <10 | --- | <10 | 22 |
| 66 | --- | --- | --- | 3 | --- | <10 | --- | 13 | 29 |
| 67 | --- | --- | --- | 4 | --- | <10 | --- | <10 | <10 |
| 68 | --- | --- | --- | 4 | --- | <10 | --- | <10 | <10 |
| 69 | --- | --- | --- | 11 | --- | <10 | --- | <10 | 26 |
| 70 | --- | --- | --- | 10 | --- | <10 | --- | <10 | 22 |
| 71 | --- | --- | --- | 37 | --- | <10 | --- | <32 | 38 |
| 72 | --- | --- | --- | 8 | --- | <10 | --- | <10 | 34 |
| 73 | --- | --- | --- | 7 | --- | <10 | --- | <10 | 39 |
| 74 | --- | --- | --- | 4 | --- | <10 | --- | <10 | <10 |
| 75 | --- | --- | --- | 13 | --- | <10 | --- | <33 | 250 |
| 76 | --- | --- | --- | 9 | --- | <10 | --- | <10 | 51 |
| 77 | --- | --- | --- | 12 | --- | <10 | --- | <22 | 67 |
| 78 | --- | --- | --- | <1 | --- | <10 | --- | 11 | <10 |
| 79 | --- | --- | --- | 5 | --- | <10 | --- | <10 | <10 |
| 80 | --- | --- | --- | 8 | --- | <10 | --- | <10 | <10 |
| 81 | --- | --- | --- | 4 | --- | <10 | --- | <10 | 10 |
| 82 | --- | --- | --- | 11 | --- | <10 | --- | <10 | 37 |
| 83 | --- | --- | --- | 12 | --- | <10 | --- | <10 | 74 |
| 84 | --- | --- | --- | 15 | --- | <10 | --- | <21 | 12 |
| 85 | --- | --- | --- | 7 | --- | <10 | --- | <10 | 13 |
| 86 | --- | --- | --- | 30 | --- | <10 | --- | <43 | 1010 |
| 87 | --- | --- | --- | 20 | --- | <10 | --- | <33 | 20 |
| 88 | --- | --- | --- | 6 | --- | <10 | --- | <10 | 14 |
| 89 | --- | --- | --- | 3 | --- | <10 | --- | <10 | <10 |
| 90 | --- | --- | --- | 2 | --- | <10 | --- | <10 | <10 |
| 91 | --- | --- | --- | 2 | --- | <10 | --- | <10 | <10 |
| 92 | --- | --- | --- | <1 | --- | <10 | --- | 57 | 50 |
| 93 | --- | --- | --- | <1 | --- | <10 | --- | 59 | 58 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 94 | --- | --- | --- | <1 | --- | <10 | --- | 71 | 27 |
| 95 | --- | --- | --- | <1 | --- | <10 | --- | 73 | 40 |
| 96 | --- | --- | --- | <1 | --- | <10 | --- | 46 | 47 |
| 97 | --- | --- | --- | <1 | --- | <10 | --- | 79 | 38 |
| 98 | --- | --- | --- | <1 | --- | <10 | --- | 64 | 46 |
| 99 | --- | --- | --- | <1 | --- | <10 | --- | 140 | 26 |
| 100 | --- | --- | --- | <1 | --- | <10 | --- | 37 | 48 |
| 101 | --- | --- | --- | <1 | --- | <10 | --- | 82 | 34 |
| 102 | --- | --- | --- | 1 | --- | <10 | --- | 110 | 26 |
| 103 | --- | --- | --- | <1 | --- | <10 | --- | 49 | 56 |
| 104 | --- | --- | --- | <1 | --- | <10 | --- | 68 | 47 |
| 105 | --- | --- | --- | 21 | --- | <22 | --- | <10 | 43 |
| 106 | 50 | <0.5 | 4 | <1 | 0.95 | <10 | <0.5 | 78 | 38 |
| 107 | 80 | <0.5 | <2 | <1 | 1.68 | <10 | <0.5 | 74 | 37 |
| 108 | 130 | 0.5 | 4 | <1 | 1.34 | <10 | <0.5 | 77 | 40 |
| 109 | --- | --- | --- | <1 | --- | <10 | --- | 130 | 53 |
| 110 | --- | --- | --- | <1 | --- | <10 | --- | 82 | 36 |
| 111 | --- | --- | --- | <1 | --- | <10 | --- | 65 | 42 |
| 112 | 140 | <0.5 | 2 | <1 | 2.54 | <10 | <0.5 | 60 | 45 |
| 113 | 80 | <0.5 | 4 | <1 | 1.29 | <10 | <0.5 | 71 | 42 |
| 114 | --- | --- | --- | <1 | --- | <10 | --- | 60 | 39 |
| 115 | 70 | <0.5 | <2 | <1 | 1.87 | <10 | <0.5 | 65 | 47 |
| 116 | 120 | <0.5 | <2 | <1 | 1.36 | <10 | <0.5 | 70 | 47 |
| 117 | 120 | <0.5 | 4 | <1 | 1.91 | <10 | <0.5 | 62 | 55 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | --- | 270 | --- | <1 | 4700 | --- | <2 | 6.0 | --- |
| 2 | --- | 100 | --- | <1 | 46900 | --- | <2 | 2.8 | --- |
| 3 | --- | 300 | --- | <1 | 1800 | --- | <2 | 5.0 | --- |
| 4 | --- | 340 | --- | <1 | 1900 | --- | <2 | 5.4 | --- |
| 5 | --- | 240 | --- | <1 | 4100 | --- | <2 | 4.6 | --- |
| 6 | --- | 160 | --- | 1 | -100 | --- | <2 | <0.5 | --- |
| 7 | --- | 140 | --- | <1 | 17900 | --- | <2 | 0.7 | --- |
| 8 | --- | 140 | --- | <1 | 72600 | --- | <2 | 0.5 | --- |
| 9 | --- | 130 | --- | <1 | 29600 | --- | <2 | <0.5 | --- |
| 10 | --- | 120 | --- | 1 | 18600 | --- | <2 | <0.5 | --- |
| 11 | --- | 220 | --- | <1 | 5800 | --- | <2 | 10.0 | --- |
| 12 | --- | 98 | --- | <1 | 66900 | --- | <2 | 2.1 | --- |
| 13 | --- | 110 | --- | <1 | 6400 | --- | <2 | 0.7 | --- |
| 14 | --- | 180 | --- | <1 | 8600 | --- | <2 | <0.5 | --- |
| 15 | --- | 200 | --- | <1 | 31200 | --- | <2 | 1.5 | --- |
| 16 | --- | 160 | --- | <1 | 51400 | --- | <2 | 0.8 | --- |
| 17 | --- | 200 | --- | <1 | 5000 | --- | <2 | 1.0 | --- |
| 18 | --- | 130 | --- | <1 | 70200 | --- | <2 | 1.7 | --- |
| 19 | --- | 150 | --- | <1 | 22000 | --- | <2 | <0.5 | --- |
| 20 | --- | 160 | --- | <1 | 2400 | --- | <2 | 5.9 | --- |
| 21 | --- | <50 | --- | <1 | 70000 | --- | <2 | 3.8 | --- |
| 22 | --- | 220 | --- | <1 | 8500 | --- | <2 | 2.2 | --- |
| 23 | --- | 220 | --- | <1 | 7200 | --- | <2 | 2.2 | --- |
| 24 | --- | 140 | --- | <1 | 22300 | --- | <2 | 3.1 | --- |
| 25 | --- | 140 | --- | <1 | 12300 | --- | <2 | 1.8 | --- |
| 26 | --- | 57 | --- | 5 | 21 | --- | <2 | 0.9 | --- |
| 27 | --- | <50 | --- | <1 | 73600 | --- | <2 | 3.1 | --- |
| 28 | --- | 170 | --- | 1 | 27100 | --- | <2 | 4.1 | --- |
| 29 | --- | 66 | --- | <1 | 47400 | --- | <2 | 2.3 | --- |
| 30 | --- | 180 | --- | <1 | 28300 | --- | <2 | 2.7 | --- |
| 31 | --- | 190 | --- | <1 | 213 | --- | <2 | 0.7 | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 32 | --- | 240 | --- | <1 | 702 | --- | <2 | <0.5 | --- |
| 33 | --- | 200 | --- | <1 | 102 | --- | <2 | <0.5 | --- |
| 34 | --- | 210 | --- | 1 | 12107 | --- | <2 | 0.8 | --- |
| 35 | --- | 200 | --- | <1 | 9224 | --- | <2 | 0.6 | --- |
| 36 | --- | <140 | --- | <1 | 78500 | --- | <2 | 4.9 | --- |
| 37 | --- | <110 | --- | <1 | 72500 | --- | <2 | 6.4 | --- |
| 38 | --- | 88 | --- | <1 | 10145 | --- | <2 | 4.4 | --- |
| 39 | --- | <50 | --- | <1 | 6281 | --- | <2 | 1.7 | --- |
| 40 | --- | <160 | --- | <1 | 22900 | --- | <2 | >10.0 | --- |
| 41 | --- | 70 | --- | <1 | 333 | --- | <2 | 4.3 | --- |
| 42 | --- | 83 | --- | 2 | 1306 | --- | <2 | 7.5 | --- |
| 43 | --- | 51 | --- | 1 | 543 | --- | <2 | 1.4 | --- |
| 44 | --- | <50 | --- | 5 | 53 | --- | <2 | 1.6 | --- |
| 45 | --- | <120 | --- | <1 | 124500 | --- | <2 | >10.0 | --- |
| 46 | --- | 78 | --- | <1 | 27 | --- | <2 | >10.0 | --- |
| 47 | --- | 240 | --- | <1 | 600 | --- | 3 | 8.7 | --- |
| 48 | --- | <50 | --- | <1 | 2123 | --- | <2 | 0.5 | --- |
| 49 | --- | <50 | --- | <1 | 10952 | --- | <2 | 1.2 | --- |
| 50 | --- | <50 | --- | <1 | 2613 | --- | <2 | 0.6 | --- |
| 51 | --- | <50 | --- | <1 | 4925 | --- | <2 | 1.1 | --- |
| 52 | --- | <50 | --- | <1 | 10084 | --- | <2 | 1.2 | --- |
| 53 | --- | <50 | --- | <1 | 18501 | --- | <2 | 1.4 | --- |
| 54 | --- | <50 | --- | <1 | 11705 | --- | <2 | 2.4 | --- |
| 55 | --- | <50 | --- | <1 | 1350 | --- | <2 | <0.5 | --- |
| 56 | --- | 56 | --- | <1 | 32600 | --- | <2 | 1.3 | --- |
| 57 | --- | <50 | --- | <1 | 17187 | --- | <2 | 1.6 | --- |
| 58 | --- | <50 | --- | <1 | 38600 | --- | <2 | 4.4 | --- |
| 59 | --- | <50 | --- | <1 | 106700 | --- | <2 | 10.0 | --- |
| 60 | --- | <110 | --- | <1 | 32 | --- | <2 | >10.0 | --- |
| 61 | --- | <50 | --- | <1 | 30 | --- | <2 | >10.0 | --- |
| 62 | --- | 56 | --- | <1 | 28 | --- | <2 | >10.0 | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 63 | --- | <50 | --- | <1 | <100 | --- | <2 | >10.0 | --- |
| 64 | --- | 59 | --- | 4 | 9620 | --- | <2 | 1.8 | --- |
| 65 | --- | <50 | --- | <1 | 21000 | --- | <2 | 0.8 | --- |
| 66 | --- | 150 | --- | <1 | 38000 | --- | <2 | 1.0 | --- |
| 67 | --- | 81 | --- | <1 | 7576 | --- | <2 | 1.5 | --- |
| 68 | --- | 73 | --- | <1 | 19500 | --- | <2 | 2.4 | --- |
| 69 | --- | <50 | --- | <1 | 45400 | --- | <2 | 4.9 | --- |
| 70 | --- | <50 | --- | <1 | 25200 | --- | <2 | 2.2 | --- |
| 71 | --- | <50 | --- | <1 | 187200 | --- | <2 | 6.5 | --- |
| 72 | --- | <50 | --- | <1 | 44400 | --- | <2 | 2.9 | --- |
| 73 | --- | <50 | --- | <1 | 19100 | --- | <2 | 1.8 | --- |
| 74 | --- | <50 | --- | <1 | 11945 | --- | <2 | 1.5 | --- |
| 75 | --- | <50 | --- | <1 | 857 | --- | <2 | 8.3 | --- |
| 76 | --- | <50 | --- | <1 | 3375 | --- | <2 | 1.0 | --- |
| 77 | --- | 56 | --- | <1 | 16500 | --- | <2 | 2.0 | --- |
| 78 | --- | 87 | --- | 3 | 47 | --- | <2 | <0.5 | --- |
| 79 | --- | <50 | --- | <1 | 15810 | --- | <2 | 1.6 | --- |
| 80 | --- | <50 | --- | <1 | 34900 | --- | <2 | 3.4 | --- |
| 81 | --- | <50 | --- | <1 | 10764 | --- | <2 | 1.4 | --- |
| 82 | --- | <50 | --- | <1 | 4746 | --- | <2 | 1.9 | --- |
| 83 | --- | <50 | --- | <1 | 17 | --- | <2 | >10.0 | --- |
| 84 | --- | <50 | --- | <1 | 80300 | --- | <2 | 5.0 | --- |
| 85 | --- | <50 | --- | <1 | 80900 | --- | <2 | 2.2 | --- |
| 86 | --- | <120 | --- | <1 | 29100 | --- | <2 | 1.5 | --- |
| 87 | --- | <50 | --- | <1 | 59300 | --- | <2 | 3.5 | --- |
| 88 | --- | <50 | --- | <1 | 3562 | --- | <2 | <0.5 | --- |
| 89 | --- | <50 | --- | <1 | 2663 | --- | <2 | <0.5 | --- |
| 90 | --- | <50 | --- | <1 | 35 | --- | <2 | <0.5 | --- |
| 91 | --- | <50 | --- | <1 | 26 | --- | <2 | <0.5 | --- |
| 92 | --- | 160 | --- | <1 | --- | --- | <2 | 8.4 | --- |
| 93 | --- | 740 | --- | <1 | --- | --- | <2 | 8.7 | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 94 | --- | 310 | --- | 1 | --- | --- | <2 | 4.5 | --- |
| 95 | --- | <50 | --- | <1 | --- | --- | <2 | 9.4 | --- |
| 96 | --- | <50 | --- | <1 | --- | --- | <2 | 8.1 | --- |
| 97 | --- | <50 | --- | 1 | --- | --- | <2 | 7.0 | --- |
| 98 | --- | 400 | --- | <1 | --- | --- | <2 | 5.8 | --- |
| 99 | --- | 300 | --- | <1 | --- | --- | <2 | 3.8 | --- |
| 100 | --- | 75 | --- | <1 | --- | --- | <2 | 7.9 | --- |
| 101 | --- | 160 | --- | <1 | --- | --- | <2 | 5.9 | --- |
| 102 | --- | 260 | --- | <1 | --- | --- | <2 | 4.2 | --- |
| 103 | --- | 370 | --- | <1 | --- | --- | <2 | 9.3 | --- |
| 104 | --- | 120 | --- | <1 | --- | --- | 2 | 8.4 | --- |
| 105 | --- | 54 | --- | 2 | --- | --- | <2 | >10.0 | --- |
| 106 | 27 | 210 | 133 | <1 | --- | 20 | 2 | 7.6 | 5.14 |
| 107 | 23 | 180 | 113 | <1 | --- | 30 | <2 | 7.8 | 4.25 |
| 108 | 28 | 200 | 137 | <1 | --- | 23 | <2 | 7.8 | 5.43 |
| 109 | --- | 160 | --- | <1 | --- | --- | <2 | 7.8 | --- |
| 110 | --- | 300 | --- | <1 | --- | --- | <2 | 6.5 | --- |
| 111 | --- | 190 | --- | <1 | --- | --- | <2 | 7.2 | --- |
| 112 | 31 | 200 | 38 | <1 | --- | 58 | <2 | 7.4 | 5.19 |
| 113 | 18 | 180 | 36 | <1 | --- | 32 | 2 | 7.7 | 2.88 |
| 114 | --- | 87 | --- | <1 | --- | --- | <2 | 7.7 | --- |
| 115 | 25 | 110 | 32 | <1 | --- | 22 | <2 | 8.4 | 2.94 |
| 116 | 26 | 99 | 26 | <1 | --- | 34 | <2 | 8.5 | 4.15 |
| 117 | 29 | 120 | 29 | <1 | --- | 30 | <2 | 9.2 | 4.22 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | --- | --- | <2 | --- | <100 | --- | 6 | --- | <0.5 |
| 2 | --- | --- | <2 | --- | <100 | --- | 7 | --- | <0.5 |
| 3 | --- | --- | <2 | --- | <100 | --- | 12 | --- | <0.5 |
| 4 | --- | --- | <2 | --- | <100 | --- | 13 | --- | <0.5 |
| 5 | --- | --- | <2 | --- | <100 | --- | 20 | --- | <0.5 |
| 6 | --- | --- | <2 | --- | <100 | --- | 7 | --- | <0.5 |
| 7 | --- | --- | <2 | --- | <100 | --- | 10 | --- | <0.5 |
| 8 | --- | --- | <2 | --- | <100 | --- | 6 | --- | <0.5 |
| 9 | --- | --- | 3 | --- | <100 | --- | 15 | --- | <0.5 |
| 10 | --- | --- | 2 | --- | <100 | --- | 11 | --- | <0.5 |
| 11 | --- | --- | <2 | --- | <100 | --- | 23 | --- | <0.5 |
| 12 | --- | --- | 4 | --- | <100 | --- | 26 | --- | <0.5 |
| 13 | --- | --- | <2 | --- | <100 | --- | 7 | --- | <0.5 |
| 14 | --- | --- | <2 | --- | <100 | --- | 8 | --- | <0.5 |
| 15 | --- | --- | <2 | --- | <100 | --- | 9 | --- | <0.5 |
| 16 | --- | --- | 3 | --- | <100 | --- | 12 | --- | <0.5 |
| 17 | --- | --- | <2 | --- | <100 | --- | 13 | --- | <0.5 |
| 18 | --- | --- | <2 | --- | <100 | --- | 8 | --- | <0.5 |
| 19 | --- | --- | <2 | --- | <100 | --- | 14 | --- | <0.5 |
| 20 | --- | --- | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 21 | --- | --- | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 22 | --- | --- | 3 | --- | <100 | --- | 17 | --- | <0.5 |
| 23 | --- | --- | <2 | --- | <100 | --- | 14 | --- | <0.5 |
| 24 | --- | --- | <2 | --- | <100 | --- | 17 | --- | <0.5 |
| 25 | --- | --- | <2 | --- | <100 | --- | 12 | --- | <0.5 |
| 26 | --- | <5 | 2 | --- | <100 | --- | 10 | --- | <0.5 |
| 27 | --- | --- | <2 | --- | <100 | --- | 8 | --- | 0.8 |
| 28 | --- | 423 | <2 | --- | <100 | --- | 7 | --- | <0.5 |
| 29 | --- | --- | 3 | --- | <100 | --- | 8 | --- | <0.5 |
| 30 | --- | 999 | <2 | --- | <100 | --- | 6 | --- | <0.5 |
| 31 | --- | <5 | <2 | --- | <100 | --- | 9 | --- | <0.5 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 32 | --- | <5 | <2 | --- | <100 | --- | 9 | --- | <0.5 |
| 33 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 34 | --- | 33 | <2 | --- | <100 | --- | 7 | --- | <0.5 |
| 35 | --- | 12 | <2 | --- | <100 | --- | 5 | --- | <0.5 |
| 36 | --- | 57 | <2 | --- | <100 | --- | <5 | --- | 1.7 |
| 37 | --- | 643 | <2 | --- | <100 | --- | <5 | --- | 1.7 |
| 38 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 39 | --- | 199 | <2 | --- | <100 | --- | 7 | --- | 0.7 |
| 40 | --- | 131 | <2 | --- | <100 | --- | <5 | --- | 2.1 |
| 41 | --- | 17 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 42 | --- | 27 | <2 | --- | <100 | --- | 6 | --- | <0.5 |
| 43 | --- | 94 | <2 | --- | <100 | --- | 6 | --- | <0.5 |
| 44 | --- | <5 | 6 | --- | <100 | --- | 14 | --- | <0.5 |
| 45 | --- | 197 | <2 | --- | <100 | --- | <5 | --- | 10.0 |
| 46 | --- | 27 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 47 | --- | --- | 8 | --- | <100 | --- | 34 | --- | <0.5 |
| 48 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 49 | --- | 16 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 50 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 51 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 52 | --- | 20 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 53 | --- | 27 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 54 | --- | 131 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 55 | --- | 17 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 56 | --- | 27 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 57 | --- | 8 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 58 | --- | 94 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 59 | --- | 27 | <2 | --- | <100 | --- | <5 | --- | 1.0 |
| 60 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | 3.9 |
| 61 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 62 | --- | 8 | <2 | --- | <100 | --- | <5 | --- | 5.2 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 63 | --- | --- | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 64 | --- | 180 | <2 | --- | <100 | --- | 7 | --- | <0.5 |
| 65 | --- | 197 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 66 | --- | 42 | <2 | --- | <100 | --- | 5 | --- | <0.5 |
| 67 | --- | 199 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 68 | --- | --- | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 69 | --- | 586 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 70 | --- | 97 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 71 | --- | 401 | <2 | --- | <100 | --- | <5 | --- | 10.0 |
| 72 | --- | 404 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 73 | --- | 145 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 74 | --- | 122 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 75 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | 14.0 |
| 76 | --- | 10 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 77 | --- | 106 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 78 | --- | <5 | 5 | --- | <100 | --- | 12 | --- | <0.5 |
| 79 | --- | 71 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 80 | --- | 427 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 81 | --- | 46 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 82 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 83 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 84 | --- | 123 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 85 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 86 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 87 | --- | 41 | <2 | --- | <100 | --- | <5 | --- | 1.2 |
| 88 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 89 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 90 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 91 | --- | <5 | <2 | --- | <100 | --- | <5 | --- | <0.5 |
| 92 | --- | --- | 4 | --- | <100 | --- | 24 | --- | <0.5 |
| 93 | --- | --- | 3 | --- | <100 | --- | 33 | --- | <0.5 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 94 | --- | --- | 4 | --- | <100 | --- | 36 | --- | <0.5 |
| 95 | --- | --- | 3 | --- | <100 | --- | 29 | --- | <0.5 |
| 96 | --- | --- | 3 | --- | <100 | --- | 24 | --- | <0.5 |
| 97 | --- | --- | 3 | --- | <100 | --- | 39 | --- | <0.5 |
| 98 | --- | --- | 6 | --- | <100 | --- | 25 | --- | <0.5 |
| 99 | --- | --- | 4 | --- | <100 | --- | 62 | --- | <0.5 |
| 100 | --- | --- | 2 | --- | <100 | --- | 22 | --- | <0.5 |
| 101 | --- | --- | 4 | --- | <100 | --- | 36 | --- | <0.5 |
| 102 | --- | --- | 5 | --- | <100 | --- | 54 | --- | <0.5 |
| 103 | --- | --- | 4 | --- | <100 | --- | 20 | --- | <0.5 |
| 104 | --- | --- | 3 | --- | <100 | --- | 30 | --- | <0.5 |
| 105 | --- | --- | <2 | --- | <100 | --- | 12 | --- | <0.5 |
| 106 | <10 | --- | 7 | <1 | <100 | 0.38 | 33 | 10 | <0.5 |
| 107 | <10 | --- | 8 | <1 | <100 | 0.41 | 35 | 10 | <0.5 |
| 108 | <10 | --- | 7 | <1 | <100 | 0.56 | 33 | 20 | <0.5 |
| 109 | --- | --- | 2 | --- | <100 | --- | 54 | --- | <0.5 |
| 110 | --- | --- | 4 | --- | <100 | --- | 34 | --- | <0.5 |
| 111 | --- | --- | 3 | --- | <100 | --- | 25 | --- | <0.5 |
| 112 | <10 | --- | 5 | <1 | <100 | 0.04 | 29 | 20 | <0.5 |
| 113 | <10 | --- | 4 | <1 | <100 | 0.06 | 29 | 10 | <0.5 |
| 114 | --- | --- | 4 | --- | <100 | --- | 24 | --- | <0.5 |
| 115 | <10 | --- | 3 | <1 | <100 | 0.04 | 26 | 10 | <0.5 |
| 116 | <10 | --- | 3 | <1 | <100 | 0.10 | 26 | 10 | <0.5 |
| 117 | <10 | --- | 3 | <1 | <100 | 0.07 | 27 | 10 | <0.5 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | --- | --- | 84 | --- | 0.06 | --- | 290 | --- | --- |
| 2 | --- | --- | 100 | --- | <0.05 | --- | 4150 | --- | --- |
| 3 | --- | --- | 230 | --- | <0.05 | --- | 89 | --- | --- |
| 4 | --- | --- | 237 | --- | <0.05 | --- | <50 | --- | --- |
| 5 | --- | --- | 120 | --- | <0.05 | --- | 81 | --- | --- |
| 6 | --- | --- | <2 | --- | 0.08 | --- | <50 | --- | --- |
| 7 | --- | --- | 39 | --- | <0.05 | --- | 160 | --- | --- |
| 8 | --- | --- | 42 | --- | <0.05 | --- | 130 | --- | --- |
| 9 | --- | --- | 48 | --- | <0.05 | --- | 2660 | --- | --- |
| 10 | --- | --- | 21 | --- | <0.05 | --- | 1100 | --- | --- |
| 11 | --- | --- | 120 | --- | 0.06 | --- | 72 | --- | --- |
| 12 | --- | --- | 29 | --- | <0.64 | --- | 610 | --- | --- |
| 13 | --- | --- | 7 | --- | <0.05 | --- | 84 | --- | --- |
| 14 | --- | --- | 4 | --- | <0.05 | --- | <50 | --- | --- |
| 15 | --- | --- | 16 | --- | <0.05 | --- | 70 | --- | --- |
| 16 | --- | --- | 5 | --- | <0.05 | --- | 120 | --- | --- |
| 17 | --- | --- | 100 | --- | <0.05 | --- | <50 | --- | --- |
| 18 | --- | --- | 190 | --- | <0.05 | --- | 1600 | --- | --- |
| 19 | --- | --- | 5 | --- | <0.05 | --- | 500 | --- | --- |
| 20 | --- | --- | 344 | --- | <0.05 | --- | <50 | --- | --- |
| 21 | --- | --- | 30 | --- | <0.05 | --- | 200 | --- | --- |
| 22 | --- | --- | 27 | --- | <0.05 | --- | 56 | --- | --- |
| 23 | --- | --- | 77 | --- | <0.05 | --- | 350 | --- | --- |
| 24 | --- | --- | 203 | --- | <0.05 | --- | 1500 | --- | --- |
| 25 | --- | --- | 100 | --- | <0.05 | --- | 1100 | --- | --- |
| 26 | --- | --- | <2 | --- | 0.10 | --- | <50 | --- | --- |
| 27 | --- | --- | 41 | --- | 0.07 | --- | <50 | --- | --- |
| 28 | --- | --- | 46 | --- | 0.06 | --- | <50 | --- | --- |
| 29 | --- | --- | 180 | --- | 0.06 | --- | <50 | --- | --- |
| 30 | --- | --- | 252 | --- | <0.05 | --- | <50 | --- | --- |
| 31 | --- | --- | 5 | --- | <0.05 | --- | <50 | --- | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 32 | --- | --- | 9 | --- | <0.05 | --- | <50 | --- | --- |
| 33 | --- | --- | 5 | --- | <0.05 | --- | <50 | --- | --- |
| 34 | --- | --- | 15 | --- | <0.05 | --- | <50 | --- | --- |
| 35 | --- | --- | 180 | --- | <0.05 | --- | <50 | --- | --- |
| 36 | --- | --- | 52 | --- | 0.11 | --- | <50 | --- | --- |
| 37 | --- | --- | 93 | --- | 0.10 | --- | 450 | --- | --- |
| 38 | --- | --- | 48 | --- | 0.09 | --- | <50 | --- | --- |
| 39 | --- | --- | 49 | --- | 0.06 | --- | <50 | --- | --- |
| 40 | --- | --- | 88 | --- | <0.05 | --- | 99 | --- | --- |
| 41 | --- | --- | 83 | --- | 0.08 | --- | <50 | --- | --- |
| 42 | --- | --- | 316 | --- | 0.10 | --- | 76 | --- | --- |
| 43 | --- | --- | 58 | --- | 0.15 | --- | <50 | --- | --- |
| 44 | --- | --- | 8 | --- | 0.10 | --- | <50 | --- | --- |
| 45 | --- | --- | 5730 | --- | <0.05 | --- | 530 | --- | --- |
| 46 | --- | --- | 36 | --- | <0.05 | --- | 190 | --- | --- |
| 47 | --- | --- | 4 | --- | 2.50 | --- | 110 | --- | --- |
| 48 | --- | --- | 5 | --- | 0.15 | --- | <50 | --- | --- |
| 49 | --- | --- | 10 | --- | 0.15 | --- | <50 | --- | --- |
| 50 | --- | --- | 6 | --- | 0.15 | --- | <50 | --- | --- |
| 51 | --- | --- | 12 | --- | 0.15 | --- | <50 | --- | --- |
| 52 | --- | --- | 9 | --- | 0.09 | --- | <50 | --- | --- |
| 53 | --- | --- | 12 | --- | 0.15 | --- | <50 | --- | --- |
| 54 | --- | --- | 56 | --- | 0.16 | --- | <50 | --- | --- |
| 55 | --- | --- | 6 | --- | 0.17 | --- | <50 | --- | --- |
| 56 | --- | --- | 259 | --- | 0.11 | --- | <50 | --- | --- |
| 57 | --- | --- | 17 | --- | 0.13 | --- | <50 | --- | --- |
| 58 | --- | --- | 247 | --- | 0.08 | --- | <50 | --- | --- |
| 59 | --- | --- | 713 | --- | 0.08 | --- | 59 | --- | --- |
| 60 | --- | --- | 780 | --- | <0.05 | --- | 3440 | --- | --- |
| 61 | --- | --- | 44 | --- | <0.05 | --- | 150 | --- | --- |
| 62 | --- | --- | 222 | --- | 0.10 | --- | 2350 | --- | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 63 | --- | --- | 1850 | --- | <0.23 | --- | 2510 | --- | --- |
| 64 | --- | --- | 37 | --- | 0.13 | --- | <50 | --- | --- |
| 65 | --- | --- | 150 | --- | 0.17 | --- | <50 | --- | --- |
| 66 | --- | --- | 16 | --- | 0.05 | --- | <50 | --- | --- |
| 67 | --- | --- | 4 | --- | 0.13 | --- | <50 | --- | --- |
| 68 | --- | --- | 8 | --- | 0.14 | --- | <50 | --- | --- |
| 69 | --- | --- | 120 | --- | 0.13 | --- | 63 | --- | --- |
| 70 | --- | --- | 110 | --- | 0.13 | --- | <50 | --- | --- |
| 71 | --- | --- | 433 | --- | 0.07 | --- | <50 | --- | --- |
| 72 | --- | --- | 77 | --- | 0.15 | --- | 52 | --- | --- |
| 73 | --- | --- | 221 | --- | 0.14 | --- | 75 | --- | --- |
| 74 | --- | --- | 8 | --- | 0.12 | --- | <50 | --- | --- |
| 75 | --- | --- | 1720 | --- | 0.12 | --- | 170 | --- | --- |
| 76 | --- | --- | 130 | --- | 0.17 | --- | <50 | --- | --- |
| 77 | --- | --- | 690 | --- | 0.14 | --- | 63 | --- | --- |
| 78 | --- | --- | 6 | --- | 0.12 | --- | <50 | --- | --- |
| 79 | --- | --- | 9 | --- | 0.12 | --- | <50 | --- | --- |
| 80 | --- | --- | 23 | --- | 0.13 | --- | <50 | --- | --- |
| 81 | --- | --- | 6 | --- | 0.13 | --- | <50 | --- | --- |
| 82 | --- | --- | 11 | --- | 0.14 | --- | <50 | --- | --- |
| 83 | --- | --- | 38 | --- | 0.07 | --- | 110 | --- | --- |
| 84 | --- | --- | 228 | --- | 0.13 | --- | <50 | --- | --- |
| 85 | --- | --- | 190 | --- | 0.14 | --- | <50 | --- | --- |
| 86 | --- | --- | 4450 | --- | 0.14 | --- | 270 | --- | --- |
| 87 | --- | --- | 336 | --- | 0.12 | --- | <50 | --- | --- |
| 88 | --- | --- | 33 | --- | 0.19 | --- | <50 | --- | --- |
| 89 | --- | --- | 16 | --- | 0.14 | --- | <50 | --- | --- |
| 90 | --- | --- | 3 | --- | 0.15 | --- | <50 | --- | --- |
| 91 | --- | --- | <2 | --- | 0.08 | --- | <50 | --- | --- |
| 92 | --- | --- | 2 | --- | 1.90 | --- | 62 | --- | --- |
| 93 | --- | --- | <2 | --- | 1.50 | --- | 230 | --- | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 94 | --- | --- | <2 | --- | 1.70 | --- | 110 | --- | --- |
| 95 | --- | --- | <2 | --- | 2.00 | --- | <50 | --- | --- |
| 96 | --- | --- | <2 | --- | 1.60 | --- | <50 | --- | --- |
| 97 | --- | --- | <2 | --- | 1.80 | --- | <50 | --- | --- |
| 98 | --- | --- | <2 | --- | 1.60 | --- | 240 | --- | --- |
| 99 | --- | --- | 4 | --- | 2.10 | --- | 68 | --- | --- |
| 100 | --- | --- | <2 | --- | 1.50 | --- | <50 | --- | --- |
| 101 | --- | --- | <2 | --- | 1.70 | --- | 58 | --- | --- |
| 102 | --- | --- | 3 | --- | 1.90 | --- | 74 | --- | --- |
| 103 | --- | --- | <2 | --- | 1.60 | --- | 200 | --- | --- |
| 104 | --- | --- | <2 | --- | 1.70 | --- | 55 | --- | --- |
| 105 | --- | --- | 150 | --- | <0.20 | --- | 150 | --- | --- |
| 106 | 2.84 | 725 | 2 | <1 | 3.10 | 0.54 | 91 | 80 | 1270 |
| 107 | 2.67 | 605 | 3 | <1 | 2.70 | 0.48 | 76 | 88 | 780 |
| 108 | 2.83 | 775 | 2 | <1 | 2.60 | 0.72 | 100 | 84 | 1300 |
| 109 | --- | --- | <2 | --- | 1.60 | --- | 110 | --- | --- |
| 110 | --- | --- | <2 | --- | 1.70 | --- | 93 | --- | --- |
| 111 | --- | --- | <2 | --- | 1.70 | --- | 59 | --- | --- |
| 112 | 1.68 | 680 | <2 | <1 | 2.40 | 0.40 | 57 | 50 | 2030 |
| 113 | 0.71 | 415 | <2 | <1 | 2.30 | 0.15 | 79 | 47 | 1650 |
| 114 | --- | --- | <2 | --- | 2.10 | --- | <50 | --- | --- |
| 115 | 2.25 | 505 | <2 | <1 | 2.50 | 0.36 | <50 | 39 | 960 |
| 116 | 2.32 | 570 | <2 | 3 | 2.60 | 0.27 | 56 | 42 | 1110 |
| 117 | 2.62 | 695 | <2 | <1 | 2.50 | 0.37 | 74 | 36 | 1090 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | --- | <10 | 11.0 | --- | <0.5 | --- | <10 | 0.3 | <200 |
| 2 | --- | <10 | 30.8 | --- | <0.5 | --- | <10 | 0.9 | <200 |
| 3 | --- | <10 | 49.4 | --- | 1.1 | --- | <10 | 0.6 | <200 |
| 4 | --- | <10 | 53.8 | --- | 1.2 | --- | <10 | 0.8 | <200 |
| 5 | --- | <10 | 24.3 | --- | 1.0 | --- | <10 | 1.8 | <200 |
| 6 | --- | <10 | 0.4 | --- | 1.4 | --- | <10 | 1.4 | <200 |
| 7 | --- | <10 | 6.0 | --- | 0.8 | --- | <10 | 1.7 | <200 |
| 8 | --- | <10 | 5.4 | --- | 0.7 | --- | <10 | <0.2 | <200 |
| 9 | --- | <10 | 1.4 | --- | 0.6 | --- | <10 | 2.0 | <200 |
| 10 | --- | <10 | 3.7 | --- | 0.8 | --- | <10 | 0.9 | <200 |
| 11 | --- | <10 | 64.7 | --- | <0.5 | --- | <10 | 0.7 | <200 |
| 12 | --- | <10 | 312.0 | --- | 1.5 | --- | <10 | 4.4 | <200 |
| 13 | --- | <10 | 2.4 | --- | <0.5 | --- | <10 | 0.8 | <200 |
| 14 | --- | <10 | 0.9 | --- | <0.5 | --- | <10 | 1.1 | <200 |
| 15 | --- | <10 | 33.8 | --- | <0.5 | --- | <10 | 0.8 | <200 |
| 16 | --- | <10 | 79.3 | --- | 1.0 | --- | <10 | 1.6 | <200 |
| 17 | --- | <10 | 52.1 | --- | 1.0 | --- | <10 | 1.7 | <200 |
| 18 | --- | <10 | 12.0 | --- | 1.5 | --- | <10 | 0.3 | <200 |
| 19 | --- | <10 | 0.8 | --- | 0.8 | --- | <10 | 2.4 | <200 |
| 20 | --- | <10 | 65.6 | --- | <0.5 | --- | <10 | 0.8 | <200 |
| 21 | --- | <10 | 70.4 | --- | 0.6 | --- | <10 | 0.8 | <200 |
| 22 | --- | <10 | 53.2 | --- | <0.5 | --- | <10 | 2.4 | <200 |
| 23 | --- | <10 | 10.0 | --- | 1.0 | --- | <10 | 1.4 | <200 |
| 24 | --- | <10 | 30.6 | --- | 1.8 | --- | <10 | <2.2 | <200 |
| 25 | --- | <10 | 8.4 | --- | 0.9 | --- | <10 | 0.4 | <200 |
| 26 | --- | 44 | 0.5 | --- | 3.6 | --- | <10 | 2.3 | <200 |
| 27 | --- | <10 | 106.0 | --- | 1.0 | --- | <10 | <0.2 | <200 |
| 28 | --- | <10 | 18.0 | --- | 1.0 | --- | <10 | <0.8 | <200 |
| 29 | --- | <10 | 15.0 | --- | 0.9 | --- | <10 | <1.6 | <200 |
| 30 | --- | <10 | 16.0 | --- | 0.6 | --- | <10 | 0.8 | <200 |
| 31 | --- | <10 | 1.2 | --- | 1.1 | --- | <10 | 2.0 | <200 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 32 | --- | <10 | 1.4 | --- | 0.6 | --- | <10 | 1.1 | <200 |
| 33 | --- | <10 | 0.6 | --- | 0.6 | --- | <10 | 0.8 | <200 |
| 34 | --- | <10 | 4.5 | --- | 0.8 | --- | <10 | 1.5 | <200 |
| 35 | --- | <10 | 13.0 | --- | 0.5 | --- | <10 | 0.9 | <200 |
| 36 | --- | <24 | 116.0 | --- | <0.5 | --- | <24 | <0.7 | <790 |
| 37 | --- | <10 | 68.9 | --- | <0.5 | --- | <10 | <1.2 | <590 |
| 38 | --- | <10 | 5.5 | --- | <0.5 | --- | 25 | <0.2 | <200 |
| 39 | --- | <10 | 263.0 | --- | 1.3 | --- | <10 | 1.2 | <530 |
| 40 | --- | <23 | 11.0 | --- | 0.8 | --- | 82 | <0.8 | <690 |
| 41 | --- | <10 | 2.8 | --- | <0.5 | --- | <10 | 0.2 | <200 |
| 42 | --- | <10 | 8.5 | --- | 1.4 | --- | <10 | 1.2 | <200 |
| 43 | --- | 13 | 2.0 | --- | 1.5 | --- | <10 | 1.1 | <200 |
| 44 | --- | 63 | 1.0 | --- | 3.1 | --- | <10 | 3.5 | <200 |
| 45 | --- | <23 | 62.3 | --- | 1.1 | --- | <21 | <4.6 | <650 |
| 46 | --- | <10 | <0.6 | --- | 0.8 | --- | <10 | <0.4 | <200 |
| 47 | --- | 17 | 1.0 | --- | 14.0 | --- | <10 | 8.2 | <200 |
| 48 | --- | <10 | 1.5 | --- | <0.5 | --- | <10 | 0.3 | <200 |
| 49 | --- | <10 | 5.8 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 50 | --- | <10 | 2.7 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 51 | --- | <10 | 4.6 | --- | 0.5 | --- | <10 | 0.3 | <200 |
| 52 | --- | <10 | 3.4 | --- | <0.5 | --- | <10 | 0.8 | <200 |
| 53 | --- | <10 | 7.3 | --- | <0.5 | --- | 20 | 0.5 | <200 |
| 54 | --- | <10 | 20.5 | --- | 0.6 | --- | <10 | 0.2 | <200 |
| 55 | --- | <10 | 3.3 | --- | <0.5 | --- | <10 | 0.2 | <200 |
| 56 | --- | <10 | 33.9 | --- | <0.5 | --- | <10 | <0.8 | <200 |
| 57 | --- | <10 | 9.0 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 58 | --- | <10 | 99.3 | --- | <0.5 | --- | 28 | <0.2 | <200 |
| 59 | --- | <10 | 104.0 | --- | <0.5 | --- | 16 | <1.8 | <200 |
| 60 | --- | <22 | 15.0 | --- | 0.6 | --- | <10 | <1.6 | <580 |
| 61 | --- | <21 | 0.5 | --- | <0.5 | --- | <10 | <0.5 | <530 |
| 62 | --- | <20 | <2.3 | --- | <0.5 | --- | <10 | <2.9 | <500 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 63 | --- | <29 | 27.0 | --- | <0.5 | --- | <10 | <0.8 | <550 |
| 64 | --- | 29 | 8.6 | --- | 2.2 | --- | <10 | 1.6 | <200 |
| 65 | --- | <10 | 4.6 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 66 | --- | 10 | 4.2 | --- | 0.7 | --- | <10 | 0.8 | <200 |
| 67 | --- | <10 | 7.4 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 68 | --- | <10 | 8.9 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 69 | --- | <10 | 56.1 | --- | <0.5 | --- | <10 | <0.5 | <200 |
| 70 | --- | <10 | 20.0 | --- | 0.6 | --- | <10 | <1.1 | <200 |
| 71 | --- | <10 | 192.0 | --- | <0.5 | --- | <10 | <4.9 | <200 |
| 72 | --- | <10 | 25.7 | --- | 0.6 | --- | <10 | <0.7 | <200 |
| 73 | --- | <10 | 25.6 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 74 | --- | <10 | 2.6 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 75 | --- | <10 | 178.0 | --- | <0.5 | --- | <10 | <7.5 | <460 |
| 76 | --- | <10 | 19.0 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 77 | --- | <10 | 61.4 | --- | <0.5 | --- | <10 | <1.7 | <200 |
| 78 | --- | 32 | 0.7 | --- | 1.8 | --- | <10 | 2.2 | <200 |
| 79 | --- | <10 | 11.0 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 80 | --- | <10 | 16.0 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 81 | --- | <10 | 6.3 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 82 | --- | <10 | 56.3 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 83 | --- | <10 | 0.3 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 84 | --- | <10 | 39.8 | --- | <0.5 | --- | <10 | <1.0 | <200 |
| 85 | --- | <10 | 25.9 | --- | <0.5 | --- | <10 | <0.4 | <200 |
| 86 | --- | <23 | 406.0 | --- | 0.7 | --- | <20 | 0.3 | <700 |
| 87 | --- | <10 | 53.1 | --- | <0.5 | --- | <10 | <1.4 | <200 |
| 88 | --- | <10 | 6.6 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 89 | --- | <10 | 4.5 | --- | <0.5 | --- | <10 | <0.2 | <200 |
| 90 | --- | <10 | 0.5 | --- | <0.5 | --- | <10 | 0.3 | <200 |
| 91 | --- | <10 | 0.3 | --- | <0.5 | --- | <10 | 0.4 | <200 |
| 92 | --- | 24 | 0.5 | --- | 20.0 | --- | <10 | 6.4 | <200 |
| 93 | --- | <10 | <0.2 | --- | 25.0 | --- | <10 | 6.3 | <200 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 94 | --- | 38 | 0.2 | --- | 15.0 | --- | <10 | 4.5 | <200 |
| 95 | --- | 17 | <0.2 | --- | 16.0 | --- | <10 | 8.2 | <200 |
| 96 | --- | <10 | <0.2 | --- | 22.0 | --- | <10 | 5.3 | <200 |
| 97 | --- | <10 | 0.3 | --- | 15.0 | --- | <10 | 8.1 | <200 |
| 98 | --- | 33 | 0.3 | --- | 15.0 | --- | <10 | 5.4 | <200 |
| 99 | --- | 39 | <0.2 | --- | 14.0 | --- | <10 | 8.3 | <200 |
| 100 | --- | <10 | <0.2 | --- | 22.0 | --- | <10 | 5.2 | <200 |
| 101 | --- | <10 | <0.2 | --- | 19.0 | --- | <10 | 6.4 | <200 |
| 102 | --- | 38 | 0.3 | --- | 15.0 | --- | <10 | 7.8 | <200 |
| 103 | --- | <10 | 0.4 | --- | 22.0 | --- | <10 | 6.4 | <200 |
| 104 | --- | <10 | 0.9 | --- | 18.0 | --- | <10 | 7.1 | <200 |
| 105 | --- | 19 | 25.6 | --- | 3.5 | --- | 55 | 2.3 | <200 |
| 106 | 2 | 36 | 0.3 | <5 | 14.0 | 4 | <10 | 7.8 | <200 |
| 107 | <2 | 27 | 0.4 | <5 | 15.0 | 4 | <10 | 7.6 | <200 |
| 108 | <2 | 24 | <0.2 | 5 | 15.0 | 6 | <10 | 7.9 | <200 |
| 109 | --- | <10 | 0.4 | --- | 27.0 | --- | <10 | 8.8 | <200 |
| 110 | --- | 18 | <0.2 | --- | 16.0 | --- | <10 | 6.4 | <200 |
| 111 | --- | 26 | <0.2 | --- | 19.0 | --- | <10 | 6.8 | <200 |
| 112 | <2 | 18 | 0.4 | 5 | 24.0 | 3 | <10 | 6.5 | <200 |
| 113 | <2 | 24 | 0.2 | <5 | 23.0 | 1 | <10 | 6.5 | <200 |
| 114 | --- | 20 | 0.3 | --- | 17.0 | --- | <10 | 6.1 | <200 |
| 115 | 4 | <10 | <0.2 | 5 | 24.0 | 5 | <10 | 6.6 | <200 |
| 116 | 8 | <10 | 0.3 | <5 | 24.0 | 5 | <10 | 6.5 | <200 |
| 117 | 6 | <10 | <0.2 | <5 | 26.0 | 8 | <10 | 6.8 | <200 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 4.7 | --- |
| 2 | --- | <1 | <1 | <20 | 1.2 | --- | --- | 14.0 | --- |
| 3 | --- | <1 | <1 | <20 | 1.2 | --- | --- | 6.8 | --- |
| 4 | --- | <1 | <1 | <20 | 1.9 | --- | --- | 6.1 | --- |
| 5 | --- | <1 | <1 | <20 | 2.1 | --- | --- | 17.0 | --- |
| 6 | --- | <1 | <1 | <20 | 1.5 | --- | --- | 2.1 | --- |
| 7 | --- | <1 | <1 | <20 | 1.2 | --- | --- | 18.0 | --- |
| 8 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 23.0 | --- |
| 9 | --- | <1 | <1 | <20 | 1.7 | --- | --- | 16.0 | --- |
| 10 | --- | <1 | <1 | <20 | 1.3 | --- | --- | 20.0 | --- |
| 11 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 10.0 | --- |
| 12 | --- | <1 | <1 | <48 | 2.2 | --- | --- | 36.0 | --- |
| 13 | --- | <1 | <1 | <20 | 0.8 | --- | --- | 9.0 | --- |
| 14 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 5.1 | --- |
| 15 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 11.0 | --- |
| 16 | --- | <1 | <1 | <20 | 2.4 | --- | --- | 16.0 | --- |
| 17 | --- | <1 | <1 | <20 | 1.5 | --- | --- | 14.0 | --- |
| 18 | --- | <1 | <1 | <20 | 1.2 | --- | --- | 38.0 | --- |
| 19 | --- | <1 | <1 | <20 | 1.1 | --- | --- | 12.0 | --- |
| 20 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 7.3 | --- |
| 21 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 12.0 | --- |
| 22 | --- | <1 | <1 | <20 | 1.0 | --- | --- | 16.0 | --- |
| 23 | --- | <1 | <1 | <20 | 1.4 | --- | --- | 37.0 | --- |
| 24 | --- | <1 | <1 | <20 | 2.7 | --- | --- | 100.0 | --- |
| 25 | --- | <1 | <1 | <20 | 1.1 | --- | --- | 35.0 | --- |
| 26 | --- | <1 | <1 | <20 | 3.5 | --- | --- | 1.7 | --- |
| 27 | --- | <1 | <1 | <20 | 1.0 | --- | --- | 21.0 | --- |
| 28 | --- | <1 | <1 | <20 | 1.0 | --- | --- | 37.0 | --- |
| 29 | --- | <1 | <1 | <20 | 1.3 | --- | --- | 80.4 | --- |
| 30 | --- | <1 | <1 | <20 | 0.5 | --- | --- | 11.0 | --- |
| 31 | --- | <1 | <1 | <20 | 1.8 | --- | --- | 3.9 | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 32 | --- | <1 | <1 | <20 | 0.9 | --- | --- | 7.8 | --- |
| 33 | --- | <1 | <1 | <20 | 1.0 | --- | --- | 3.2 | --- |
| 34 | --- | <1 | <1 | <20 | 1.3 | --- | --- | 15.0 | --- |
| 35 | --- | <1 | <1 | <20 | 0.9 | --- | --- | 19.0 | --- |
| 36 | --- | <1 | <1 | <73 | <1.5 | --- | --- | 21.0 | --- |
| 37 | --- | <1 | <1 | <54 | 1.3 | --- | --- | 39.0 | --- |
| 38 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 4.1 | --- |
| 39 | --- | <1 | <1 | <46 | 1.5 | --- | --- | 3.8 | --- |
| 40 | --- | <1 | <1 | <63 | <1.3 | --- | --- | 23.0 | --- |
| 41 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 1.1 | --- |
| 42 | --- | <1 | <1 | <20 | 1.8 | --- | --- | 2.9 | --- |
| 43 | --- | <1 | <1 | <20 | 1.7 | --- | --- | 5.0 | --- |
| 44 | --- | <1 | <1 | <20 | 5.5 | --- | --- | 5.5 | --- |
| 45 | --- | <1 | 2 | <63 | <1.3 | --- | --- | 143.0 | --- |
| 46 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 13.0 | --- |
| 47 | --- | 5 | 1 | <20 | 4.4 | --- | --- | 2.5 | --- |
| 48 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 0.9 | --- |
| 49 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 2.7 | --- |
| 50 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 0.9 | --- |
| 51 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 1.3 | --- |
| 52 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 2.9 | --- |
| 53 | --- | <1 | <1 | <20 | 0.7 | --- | --- | 2.8 | --- |
| 54 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 4.2 | --- |
| 55 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 1.1 | --- |
| 56 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 26.0 | --- |
| 57 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 5.6 | --- |
| 58 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 9.5 | --- |
| 59 | --- | <1 | <1 | <20 | 0.8 | --- | --- | 60.9 | --- |
| 60 | --- | <1 | <1 | <56 | <1.1 | --- | --- | 47.0 | --- |
| 61 | --- | <1 | <1 | <49 | <1.0 | --- | --- | 15.0 | --- |
| 62 | --- | <1 | <1 | <48 | <0.5 | --- | --- | 94.1 | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 63 | --- | <1 | <1 | <72 | <1.4 | --- | --- | 25.0 | --- |
| 64 | --- | <1 | <1 | <20 | 2.7 | --- | --- | 19.0 | --- |
| 65 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 10.0 | --- |
| 66 | --- | <1 | <1 | <20 | 1.2 | --- | --- | 28.0 | --- |
| 67 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 4.7 | --- |
| 68 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 9.0 | --- |
| 69 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 16.0 | --- |
| 70 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 36.0 | --- |
| 71 | --- | <1 | <1 | <45 | <0.5 | --- | --- | 154.0 | --- |
| 72 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 23.0 | --- |
| 73 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 13.0 | --- |
| 74 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 5.0 | --- |
| 75 | --- | <1 | 1 | <56 | <0.5 | --- | --- | 239.0 | --- |
| 76 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 11.0 | --- |
| 77 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 57.8 | --- |
| 78 | --- | <1 | <1 | <20 | 2.6 | --- | --- | 2.9 | --- |
| 79 | --- | <1 | <1 | <20 | 0.5 | --- | --- | 7.4 | --- |
| 80 | --- | <1 | <1 | <20 | 0.5 | --- | --- | 10.0 | --- |
| 81 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 3.9 | --- |
| 82 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 8.0 | --- |
| 83 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 8.6 | --- |
| 84 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 32.0 | --- |
| 85 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 13.0 | --- |
| 86 | --- | <1 | 3 | <61 | <1.2 | --- | --- | 8.0 | --- |
| 87 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 46.0 | --- |
| 88 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 8.5 | --- |
| 89 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 6.1 | --- |
| 90 | --- | <1 | <1 | <20 | <0.5 | --- | --- | 1.7 | --- |
| 91 | --- | <1 | <1 | <20 | 0.6 | --- | --- | 1.6 | --- |
| 92 | --- | 1 | <1 | <20 | 2.5 | --- | --- | 1.2 | --- |
| 93 | --- | 2 | <1 | <20 | 6.8 | --- | --- | 1.3 | --- |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 94 | --- | 1 | <1 | <20 | 9.1 | --- | --- | 3.1 | --- |
| 95 | --- | 3 | 1 | <20 | 2.9 | --- | --- | 0.8 | --- |
| 96 | --- | 2 | <1 | <20 | 4.5 | --- | --- | 1.6 | --- |
| 97 | --- | 2 | 1 | <20 | 7.9 | --- | --- | 2.5 | --- |
| 98 | --- | 2 | <1 | <20 | 5.6 | --- | --- | 1.7 | --- |
| 99 | --- | 3 | <1 | <20 | 15.0 | --- | --- | 4.3 | --- |
| 100 | --- | 2 | <1 | <20 | 4.7 | --- | --- | 1.3 | --- |
| 101 | --- | 2 | <1 | <20 | 7.6 | --- | --- | 2.4 | --- |
| 102 | --- | 3 | <1 | <20 | 13.0 | --- | --- | 4.0 | --- |
| 103 | --- | 2 | <1 | <20 | 2.6 | --- | --- | 1.0 | --- |
| 104 | --- | 2 | <1 | <20 | 4.2 | --- | --- | 1.3 | --- |
| 105 | --- | <1 | <1 | <41 | 3.6 | --- | --- | 10.0 | --- |
| 106 | 85 | 4 | 1 | <20 | 4.0 | 0.50 | <10 | 1.7 | <10 |
| 107 | 157 | 4 | 1 | <20 | 3.8 | 0.32 | 40 | 1.7 | <10 |
| 108 | 194 | 4 | <1 | <20 | 3.8 | 0.55 | 10 | 1.6 | <10 |
| 109 | --- | 3 | <1 | <20 | 10.0 | --- | --- | 3.1 | --- |
| 110 | --- | 3 | <1 | <20 | 5.2 | --- | --- | 1.7 | --- |
| 111 | --- | 3 | <1 | <20 | 4.8 | --- | --- | 1.5 | --- |
| 112 | 224 | 3 | <1 | <20 | 4.3 | 0.39 | <10 | 1.8 | <10 |
| 113 | 80 | 3 | <1 | <20 | 4.2 | 0.30 | 30 | 1.6 | <10 |
| 114 | --- | 3 | <1 | <20 | 3.5 | --- | --- | 1.1 | --- |
| 115 | 162 | 2 | 1 | <20 | 2.6 | 0.28 | <10 | 1.4 | <10 |
| 116 | 135 | 2 | <1 | <20 | 2.9 | 0.19 | <10 | 1.0 | <10 |
| 117 | 167 | 2 | <1 | <20 | 3.1 | 0.38 | <10 | 1.0 | <10 |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 1 | --- | <2 | --- | <5 | 880 | --- | <500 | | |
| 2 | --- | <2 | --- | <5 | 18000 | --- | <500 | | |
| 3 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 4 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 5 | --- | <2 | --- | <5 | 420 | --- | <500 | | |
| 6 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 7 | --- | <2 | --- | <5 | 340 | --- | <500 | | |
| 8 | --- | <2 | --- | <5 | 490 | --- | <500 | | |
| 9 | --- | <2 | --- | <5 | 4200 | --- | <500 | | |
| 10 | --- | <2 | --- | <5 | 2400 | --- | <500 | | |
| 11 | --- | 3 | --- | <5 | <200 | --- | <500 | | |
| 12 | --- | <10 | --- | 9 | 3300 | --- | <500 | | |
| 13 | --- | <2 | --- | <5 | 230 | --- | <500 | | |
| 14 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 15 | --- | <2 | --- | <5 | 1500 | --- | <500 | | |
| 16 | --- | <2 | --- | <5 | 1700 | --- | <500 | | |
| 17 | --- | 2 | --- | <5 | 1300 | --- | <500 | | |
| 18 | --- | <2 | --- | <5 | 7400 | --- | <500 | | |
| 19 | --- | <2 | --- | <5 | 1000 | --- | <500 | | |
| 20 | --- | <2 | --- | <5 | 360 | --- | <500 | | |
| 21 | --- | <2 | --- | <5 | 400 | --- | <500 | | |
| 22 | --- | <2 | --- | <5 | 550 | --- | <500 | | |
| 23 | --- | <2 | --- | <5 | 650 | --- | <500 | | |
| 24 | --- | 4 | --- | 8 | 7300 | --- | <500 | | |
| 25 | --- | <2 | --- | <5 | 3400 | --- | <500 | | |
| 26 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 27 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 28 | --- | <2 | --- | <5 | 620 | --- | <500 | | |
| 29 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 30 | --- | 5 | --- | <5 | <200 | --- | <500 | | |
| 31 | --- | <2 | --- | <5 | <200 | --- | <500 | | |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 32 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 33 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 34 | --- | 2 | --- | <5 | <200 | --- | <500 | | |
| 35 | --- | <2 | --- | <5 | 220 | --- | <500 | | |
| 36 | --- | <2 | --- | 20 | 1900 | --- | <500 | | |
| 37 | --- | <2 | --- | 9 | 3300 | --- | <500 | | |
| 38 | --- | <2 | --- | <5 | 250 | --- | <500 | | |
| 39 | --- | 3 | --- | 7 | 410 | --- | <500 | | |
| 40 | --- | <2 | --- | <5 | 410 | --- | <500 | | |
| 41 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 42 | --- | <2 | --- | <5 | 260 | --- | <500 | | |
| 43 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 44 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 45 | --- | <2 | --- | 8 | 3000 | --- | <500 | | |
| 46 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 47 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 48 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 49 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 50 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 51 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 52 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 53 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 54 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 55 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 56 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 57 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 58 | --- | 3 | --- | <5 | 520 | --- | <500 | | |
| 59 | --- | 3 | --- | <5 | 310 | --- | <500 | | |
| 60 | --- | <2 | --- | 18 | 8600 | --- | <500 | | |
| 61 | --- | <2 | --- | 9 | 350 | --- | <500 | | |
| 62 | --- | <2 | --- | 13 | 3700 | --- | <500 | | |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona.
--Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 63 | --- | <16 | --- | 9 | 1800 | --- | <500 | | |
| 64 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 65 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 66 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 67 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 68 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 69 | --- | <2 | --- | <5 | 370 | --- | <500 | | |
| 70 | --- | <2 | --- | <5 | 240 | --- | <500 | | |
| 71 | --- | <2 | --- | 12 | 1300 | --- | <500 | | |
| 72 | --- | <2 | --- | <5 | 600 | --- | <500 | | |
| 73 | --- | <2 | --- | <5 | 970 | --- | <500 | | |
| 74 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 75 | --- | <2 | --- | 5 | 580 | --- | <500 | | |
| 76 | --- | <2 | --- | <5 | 280 | --- | <500 | | |
| 77 | --- | <2 | --- | <5 | 510 | --- | <500 | | |
| 78 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 79 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 80 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 81 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 82 | --- | <2 | --- | <5 | 270 | --- | <500 | | |
| 83 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 84 | --- | <2 | --- | <5 | 290 | --- | <500 | | |
| 85 | --- | <2 | --- | <5 | 240 | --- | <500 | | |
| 86 | --- | <2 | --- | 14 | 590 | --- | <500 | | |
| 87 | --- | <2 | --- | <5 | 1300 | --- | <500 | | |
| 88 | --- | <2 | --- | <5 | 640 | --- | <500 | | |
| 89 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 90 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 91 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 92 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 93 | --- | <2 | --- | <5 | <200 | --- | <500 | | |

Table 2.--Analytical data for samples collected from the Kaibab National Forest, Arizona. --Continued

| Sample # | BC-INA Ag ppm | CX-ICP Ag ppm | CX-ICP Al pct | BC-INA As ppm | CX-ICP As ppm | BC-INA Au ppb | BC-FA/AA Au ppb | CX-FA/AA Au ppb | BC-INA Ba ppm |
|---|---|---|---|---|---|---|---|---|---|
| 94 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 95 | --- | <2 | --- | <5 | 220 | --- | <500 | | |
| 96 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 97 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 98 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 99 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 100 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 101 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 102 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 103 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 104 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 105 | --- | <11 | --- | <5 | 760 | --- | <500 | | |
| 106 | 66 | <2 | <10 | <5 | <200 | 66 | 520 | | |
| 107 | 47 | <2 | <10 | <5 | <200 | 54 | <500 | | |
| 108 | 70 | <2 | <10 | <5 | <200 | 68 | 650 | | |
| 109 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 110 | --- | <2 | --- | <5 | <200 | --- | <500 | | |
| 111 | --- | 2 | --- | <5 | <200 | --- | <500 | | |
| 112 | 135 | 3 | <10 | <5 | <200 | 72 | 620 | | |
| 113 | 85 | <2 | <10 | <5 | <200 | 50 | <500 | | |
| 114 | --- | 3 | --- | <5 | <200 | --- | <500 | | |
| 115 | 79 | <2 | <10 | <5 | <200 | 34 | <500 | | |
| 116 | 87 | <2 | 10 | <5 | <200 | 40 | <500 | | |
| 117 | 99 | 4 | <10 | <5 | <200 | 50 | 620 | | |

Table 4.--Location and characteristics of circular features identified by Petroleum Information Corp. in the Tusayan Ranger District, Kaibab National Forest, Arizona. (*, indicates that both Petroleum Information and the Bureau of Mines/U.S.G.S identified the same feature. #, feature number; D, drainage; T, topography; C, color; V, vegetation.)

| # | D | T | C | V |
|---|---|---|---|---|
| 1 | | X | | |
| 2 | | X | | X |
| 3 | | X | X | |
| 4 | | X | X | |
| 5 | | X | X | |
| 6 | | X | X | |
| 7 | | X | X | |
| 8 | | X | X | |
| 9 | | X | X | |
| 10 | X | X | | |
| 11 | | X | | X |
| 12 | | X | | X |
| 13 | | X | | |
| 14 | X | X | X | |
| 15 | X | X | | |
| 16 | | X | X | |
| 17 | | X | X | |
| 18 | | X | X | |
| 19 | | X | | |
| 20 | | X | | X |
| 21 | X | X | X | |
| 22 | | X | X | |
| 23 | | X | | |
| 24 | | X | X | |
| 25 | | X | X | |
| 26 | X | | X | |
| 27 | | X | X | |
| 28 | | | X | |
| 29 | | X | X | |
| 30 | X | X | | |
| 31 | | X | X | |
| 32 | X | X | | |
| 33 | | X | X | |
| 34 | | X | X | |
| 35 | | X | X | |
| 36 | | X | X | |
| 37 | | X | X | |
| 38 | X | X | | |
| 39 | | X | | X |
| 40 | | X | | |
| 41 | | X | X | |
| 42 | | X | | X |
| 43 | | X | | X |
| 44 | X | X | | |
| 45 | | X | | |
| 46 | | X | X | |
| 47 | | X | X | |
| 48 | | X | X | |
| 49 | X | X | | |
| 50 | | X | | |
| 51 | X | X | | X |
| 52 | X | X | | |
| 53 | X | X | X | |
| 54 | X | X | | |
| 55 | | X | | |
| 56 | | | | X |
| 57 | | X | | X |
| 58 | | X | X | |
| 59 | | | | X |
| 60 | | X | | X |
| 61 | | X | | |
| 62 | | | | X |
| 63 | | X | X | |
| 64* | | | X | X |
| 65* | X | | | X |
| 66 | | | X | |
| 67 | | X | X | |
| 68 | | X | | |
| 69* | | | X | X |
| 70 | X | | | |
| 71 | | X | X | |
| 72 | | X | | |
| 73 | | | X | |
| 74 | | X | | |
| 75 | X | X | | |
| 76 | | X | X | |
| 77 | X | X | X | |
| 78* | | X | X | |
| 79 | | X | | |
| 80 | | X | | |
| 81 | X | | X | |
| 82 | | | X | |
| 83 | | | X | |
| 84 | | | X | |

Table 4.--Location and characteristics of circular features identified by Petroleum Information Corp. in the Tusayan Ranger District, Kaibab National Forest, Arizona. (*, indicates that both Petroleum Information and the Bureau of Mines/U.S.G.S identified the same feature. #, feature number; D, drainage; T, topography; C, color; V, vegetation.)--Continued

| # | D | T | C | V |
|---|---|---|---|---|
| 85* | | X | X | |
| 86* | | X | X | |
| 87* | | | X | |
| 88 | | | X | |
| 89 | | X | X | |
| 90* | | X | X | |
| 91 | | X | | |
| 92* | | X | | |
| 93 | X | | X | |
| 94 | | X | | X |
| 95* | | X | X | |
| 96* | | X | | X |
| 97* | | X | | X |
| 98* | X | | | |
| 99 | | | X | |
| 100* | | | X | |
| 101* | | | | X |
| 102 | | X | | X |
| 103 | | X | | X |
| 104 | | X | | X |
| 105 | | | X | |
| 106 | | X | | |
| 107 | | | | X |
| 108 | | | | X |
| 109* | X | X | | |
| 110 | | X | | |
| 111 | | X | | X |
| 112* | | | X | |
| 113 | | | | X |
| 114 | | X | X | |
| 115* | X | X | | |
| 116 | | X | | X |
| 117 | | X | | X |
| 118 | | X | X | |
| 119 | | | | X |
| 120* | | X | | |
| 121 | | | X | |
| 122* | | X | | X |
| 123 | | | X | |
| 124 | | X | | X |
| 125 | | X | | X |
| 126 | | X | | X |
| 127* | X | | | |
| 128* | | X | X | X |
| 129 | | X | | X |
| 130 | | X | | X |
| 131 | | X | | X |
| 132 | | X | | X |
| 133 | | X | X | |
| 134 | | X | X | |
| 135 | | X | X | |
| 136 | | X | | |
| 137 | | X | | |
| 138 | | X | X | |
| 139 | | X | | |
| 140* | | X | | X |
| 141* | | X | | X |
| 142* | | X | | X |
| 143* | | X | | X |
| 144 | | X | | X |
| 145 | | X | | X |
| 146* | | X | | X |
| 147* | | X | | X |
| 148* | | X | X | |
| 149 | | X | X | X |
| 150* | | | X | |
| 151 | | X | X | X |
| 152* | | | X | X |
| 153 | | | X | |
| 154 | | X | | |
| 155 | | | X | X |
| 156 | | X | X | |
| 157 | | | X | X |
| 158 | | | | X |
| 159 | | X | X | |
| 160 | | | X | |
| 161 | | | X | |
| 162 | | X | X | |
| 163 | | X | X | |
| 164* | | X | X | |
| 165 | X | X | | |
| 166 | | X | | |

Table 4.--Location and characteristics of circular features identified by Petroleum Information Corp. in the Tusayan Ranger District, Kaibab National Forest, Arizona. (*, indicates that both Petroleum Information and the Bureau of Mines/U.S.G.S identified the same feature. #, feature number; D, drainage; T, topography; C, color; V, vegetation.)--Continued

| # | D | T | C | V | # | D | T | C | V |
|---|---|---|---|---|---|---|---|---|---|
| 167* | | X | | X | 209* | | X | | X |
| 168 | | X | | | 210* | | X | | X |
| 169* | | X | | | 211 | | X | | X |
| 170 | | X | | | 212 | | | | X |
| 171* | | X | | X | 213 | | | | X |
| 172 | | X | | X | 214 | | X | | |
| 173 | | X | X | | 215 | | | | X |
| 174 | | X | | X | 216 | | X | X | |
| 175 | | X | | X | 217* | X | X | X | |
| 176* | | X | | X | 218 | | | X | X |
| 177* | | X | | X | 219 | | X | | |
| 178 | | X | | X | 220 | | X | X | |
| 179 | | X | X | X | 221 | X | X | | |
| 180 | | X | | X | 222 | X | X | | |
| 181 | | X | X | X | 223* | | | | X |
| 182 | | X | | | 224* | | | X | |
| 183* | | X | | X | 225 | | | X | |
| 184* | | X | | X | 226 | X | X | | X |
| 185* | | X | | X | 227 | | | X | |
| 186* | | X | | X | 228 | | | | X |
| 187* | | X | | X | 229 | | | X | |
| 188 | | X | | | 230* | X | X | | |
| 189 | | | | X | 231* | X | X | | |
| 190 | | X | X | | 232 | | | | X |
| 191 | | X | | | 233 | | | | X |
| 192* | | X | X | | 234 | | | X | |
| 193 | | X | | X | 235* | | X | | |
| 194 | | X | | X | 236* | | X | X | X |
| 195 | | X | | X | 237 | | X | X | |
| 196 | | X | | X | 238 | | X | X | |
| 197* | | X | | X | 239* | | X | | X |
| 198 | X | | | | 240 | X | X | | |
| 199 | | X | X | | 241 | | X | X | |
| 200 | | | X | X | 242 | | X | X | |
| 201* | | X | | X | 243 | | X | | X |
| 202 | | X | X | | 244 | | X | X | |
| 203 | X | X | | | 245* | | | X | |
| 204 | | X | | X | 246 | | | X | |
| 205 | X | X | | | 247 | | | X | |
| 206 | | | X | | 248 | | X | X | |
| 207* | | X | | X | 249 | | X | X | |
| 208 | | X | | X | 250 | | X | | |

Table 4.--Location and characteristics of circular features identified by Petroleum Information Corp. in the Tusayan Ranger District, Kaibab National Forest, Arizona. (*, indicates that both Petroleum Information and the Bureau of Mines/U.S.G.S identified the same feature. #, feature number; D, drainage; T, topography; C, color; V, vegetation.)--Continued

| # | D | T | C | V |
|---|---|---|---|---|
| 251 | | X | | |
| 252 | | | X | X |
| 253 | | X | | X |
| 254 | | X | | X |
| 255 | | X | | X |
| 256 | | X | | X |
| 257 | | | | X |
| 258 | | | | X |
| 259 | | | | X |
| 260 | | | | X |
| 261 | | | | X |
| 262 | | | | X |
| 263 | | | | X |
| 264 | | | | X |
| 265 | | X | X | |
| 266 | | X | | |
| 267 | | X | | |
| 268 | | X | | X |
| 269 | | X | X | |
| 270 | | X | X | |
| 271 | | | | X |
| 272 | | | X | X |
| 273 | | | X | |
| 274 | | | | X |
| 275 | X | | | X |
| 276 | | | | X |
| 277 | | | X | |
| 278 | | X | X | |
| 279 | | | | X |
| 280 | | | | X |
| 281 | | | | X |
| 282 | | | | X |
| 283 | | | | X |
| 284 | X | X | | |
| 285 | | X | X | X |
| 286 | | X | | X |
| 287 | | | X | |
| 288 | | X | X | |
| 289 | | X | | X |
| 290 | | X | | X |
| 291 | | X | | X |
| 292 | | X | | X |
| 293 | | X | X | |
| 294 | | X | X | |
| 295 | | X | | |
| 296 | | | X | X |
| 297 | | X | X | |
| 298 | | X | X | |
| 299 | | X | X | |
| 300 | | X | | |
| 301 | | X | X | |
| 302 | | X | | X |
| 303 | | | | X |
| 304 | X | X | X | |
| 305 | X | X | | |
| 306 | | X | X | |
| 307 | | X | X | |
| 308 | X | X | | |
| 309 | X | X | X | |
| 310 | | | X | |
| 311 | | X | X | |
| 312 | | X | X | |
| 313 | | | X | |
| 314 | | | X | |
| 315 | | X | X | |
| 316 | X | X | | |
| 317 | | | X | |
| 318 | | X | X | |
| 319 | | X | | |
| 320 | | | X | |
| 321 | | X | | |
| 322 | | X | X | |
| 323 | | | | X |
| 324 | | | | X |
| 325 | | X | | X |
| 326 | | | | X |
| 327 | | | | X |
| 328 | | X | | X |
| 329 | | X | | X |
| 330 | | X | | X |
| 331 | | X | | X |
| 332 | | X | | X |
| 333 | X | X | | |
| 334 | | | | X |

Table 4.--Location and characteristics of circular features identified by Petroleum Information Corp. in the Tusayan Ranger District, Kaibab National Forest, Arizona. (*, indicates that both Petroleum Information and the Bureau of Mines/U.S.G.S identified the same feature. #, feature number; D, drainage; T, topography; C, color; V, vegetation.)--Continued

| # | D | T | C | V |
|---|---|---|---|---|
| 335 | X | | | X |
| 336 | | X | | |
| 337 | | | | X |
| 338 | | | | X |
| 339 | | | | X |
| 340 | | X | X | |
| 341 | | X | X | |
| 342 | | | | X |
| 343 | | | | X |
| 344 | X | | | |
| 345 | | X | | |
| 346 | | | | X |
| 347 | | X | | X |
| 348 | | | | X |
| 349 | | | | X |
| 350 | | | | X |
| 351 | | | | X |
| 352 | | | | X |
| 353 | | | | X |
| 354 | | X | | X |
| 355 | | X | X | |
| 356 | | X | X | |
| 357 | | X | | X |
| 358 | | | X | |
| 359 | | X | X | |
| 360 | | | X | |
| 361 | | X | | X |
| 362 | | | X | |
| 363 | | | | X |
| 364 | | | | X |
| 365 | X | X | | |
| 366 | | X | | X |
| 367 | | | | X |
| 368 | | X | X | |
| 369 | | | X | X |
| 370 | | | X | |
| 371 | | | X | |
| 372 | | X | | |
| 373 | | | X | |
| 374 | | | | X |
| 375 | | | | X |
| 376 | | | X | |
| 377 | | | | X |
| 378 | X | X | | |
| 379 | | X | | |
| 380 | | X | | |
| 381 | | X | | X |
| 382 | | X | X | |
| 383 | | X | X | |
| 384 | | X | | |
| 385 | | | X | |
| 386 | | X | X | |
| 387 | | | X | |
| 388 | | | X | |
| 389 | | X | | |
| 390 | | X | X | |
| 391 | | | | X |
| 392 | | X | X | |
| 393 | | X | | |
| 394 | X | | X | |
| 395 | | X | | X |
| 396 | | | | X |
| 397 | | | | X |
| 398 | | | | X |
| 399 | | X | | X |
| 400 | | X | X | |
| 401 | | X | X | |
| 402 | | X | X | |
| 403 | X | | | |
| 404 | X | X | | |
| 405 | | | | X |
| 406 | | X | X | |
| 407 | | X | | X |
| 408 | X | X | | |
| 409 | | | X | |
| 410 | | | X | X |
| 411 | | | | X |
| 412 | | X | | X |
| 413 | | | | X |
| 414 | | | | X |
| 415 | X | X | | X |
| 416 | X | X | | |
| 417 | | | X | X |
| 418 | | | X | X |

Table 4.--Location and characteristics of circular features identified by Petroleum Information Corp. in the Tusayan Ranger District, Kaibab National Forest, Arizona. (*, indicates that both Petroleum Information and the Bureau of Mines/U.S.G.S identified the same feature. #, feature number; D, drainage; T, topography; C, color; V, vegetation.)--Continued

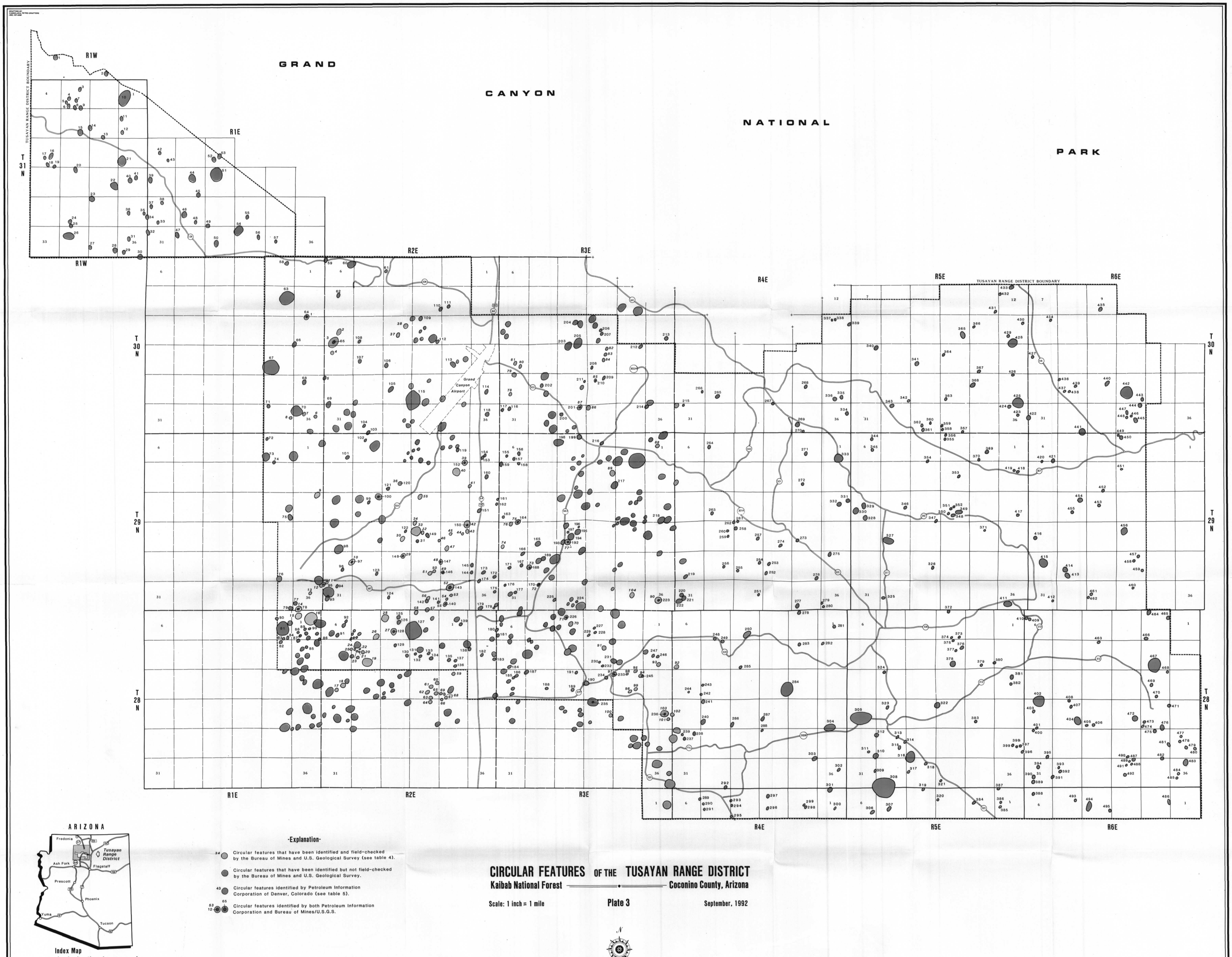
| # | D | T | C | V |
|---|---|---|---|---|
| 419 | | | X | X |
| 420 | | X | | X |
| 421 | | X | | X |
| 422 | | | | X |
| 423 | | X | | |
| 424 | | X | X | |
| 425 | X | X | X | |
| 426 | | | | X |
| 427 | | X | X | |
| 428 | X | X | | |
| 429 | | | | X |
| 430 | | | | X |
| 431 | | | X | X |
| 432 | | | | X |
| 433 | X | X | | |
| 434 | | | | X |
| 435 | | X | X | X |
| 436 | | | | X |
| 437 | | X | X | |
| 438 | | X | X | |
| 439 | | X | X | |
| 440 | | X | | X |
| 441 | | | | X |
| 442 | X | X | | |
| 443 | | X | | X |
| 444 | | X | | X |
| 445 | | X | | X |
| 446 | | X | X | |
| 447 | | X | X | X |
| 448 | | X | X | |
| 449 | | | X | X |
| 450 | | X | | |
| 451 | | X | | X |
| 452 | | | | X |
| 453 | | X | | X |
| 454 | X | X | | |
| 455 | | | | X |
| 456 | X | X | | |
| 457 | | X | | X |
| 458 | | X | X | |
| 459 | | X | X | |
| 460 | | X | X | |
| 461 | | X | | |
| 462 | | X | | |
| 463 | | | | X |
| 464 | X | X | | |
| 465 | | | X | |
| 466 | | | X | |
| 467 | | X | X | X |
| 468 | | | X | |
| 469 | X | X | | |
| 470 | | X | X | |
| 471 | | X | X | |
| 472 | | X | | X |
| 473 | | | X | |
| 474 | | | X | |
| 475 | | X | | |
| 476 | | | X | |
| 477 | | X | | |
| 478 | | | X | |
| 479 | | | X | |
| 480 | | | X | |
| 481 | | X | X | |
| 482 | | X | X | |
| 483 | | | X | |
| 484 | | | X | |
| 485 | | | X | |
| 486 | | X | X | |
| 487 | | X | X | |
| 488 | | | X | |
| 489 | | | X | |
| 490 | | | X | |
| 491 | | | X | |
| 492 | | | X | |
| 493 | | X | | |
| 494 | | X | X | |
| 495 | | X | | |

Table 5.--Location and characteristics of field-checked circular features identified by the Bureau of Mines and U.S.G.S in the Tusayan Ranger District, Kaibab National Forest, Arizona. (*, indicates that both Petroleum Information and the Bureau of Mines/U.S.G.S identified the same feature. #, feature number; C1, indicates concentric, inward dipping beds and visible alteration; C2, indicates inward dipping beds, but no visible alteration; C3, indicates visible alteration and no inward dipping beds; C4, circular feature, due to vegetation or topography, but no visible alteration or inward dipping beds; C?, indicates a circular feature, but no obvious dipping beds, alteration, vegetation change or topography delineation. Classification system adapted from Wenrich and others, 1990.)

| # | C1 | C2 | C3 | C4 | C? | # | C1 | C2 | C3 | C4 | C? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1* | | | | X | | 34 | | | | X | |
| 2 | | | | | X | 35 | | | | | X |
| 3* | | | | | X | 36* | X | | | | |
| 4 | | | | X | | 37 | | X | | | |
| 5 | | | | | X | 38 | | | | | X |
| 6 | | | | X | | 39* | | | X | | |
| 7 | | | | | X | 40* | | X | | | |
| 8 | | | | | X | 41 | | | X | | |
| 9 | | | | X | | 42* | | | X | | |
| 10* | | | | X | | 43 | | | X | | |
| 11 | | | | | X | 44 | | X | | | |
| 12* | | | | | X | 45 | | | | | X |
| 13 | | | | | X | 46 | | X | | | |
| 14* | | | | | X | 47 | | X | | | |
| 15 | | | | | X | 48* | | X | | | |
| 16 | | | | | X | 49* | | | X | | |
| 17 | | | | X | | 50 | | | X | | |
| 18 | | | | X | | 51 | X | | | | |
| 19 | | | | X | | 52* | | X | | | |
| 20 | | X | | | | 53 | | X | | | |
| 21 | | X | | | | 54 | | X | | | |
| 22 | | X | | | | 55 | | X | | | |
| 23 | | X | | | | 56 | | | | X | |
| 24 | | X | | | | 57 | | | | X | |
| 25 | | X | | | | 58 | | | | X | |
| 26 | | X | | | | 59 | | X | | | |
| 27* | | | X | | | 60 | | X | | | |
| 28 | | | | | X | 61 | X | | | | |
| 29* | | | | | X | 62 | X | | | | |
| 30 | | | X | | | 63 | X | | | | |
| 31 | | | X | | | 64 | | X | | | |
| 32 | | | X | | | 65 | X | | | | |
| 33 | | X | | | | 66 | X | | | | |

Table 5.--Location and characteristics of field-checked circular features identified by the Bureau of Mines and U.S.G.S in the Tusayan Ranger District, Kaibab National Forest, Arizona. (*, indicates that both Petroleum Information and the Bureau of Mines/U.S.G.S identified the same feature. #, feature number; CF1, indicates concentric, inward dipping beds and visible alteration; C2, indicates inward dipping beds, but no visible alteration; C3, indicates visible alteration and no inward dipping beds; C4, circular feature, due to vegetation or topography, but no visible alteration or inward dipping beds; C?, indicates a circular feature, but no obvious dipping beds, alteration, vegetation change or topography delineation. Classification system adapted from Wenrich and others, 1990.)

| # | C1 | C2 | C3 | C4 | C? |
|---|---|---|---|---|---|
| 67 | | | | | X |
| 68 | | | | | X |
| 69 | X | | | | |
| 70 | X | | | | |
| 71* | | | X | | |
| 72* | | | | X | |
| 73* | | | | X | |
| 74 | | | | | X |
| 75 | | | | | X |
| 76 | | | | | X |
| 77* | | | | | X |
| 78 | | | | | X |
| 79 | | | | | X |
| 80 | | | | | X |
| 81 | | | | | X |
| 82 | | | | | X |
| 83 | | | | | X |
| 84 | | | | | X |
| 85* | | | | | X |
| 86 | | | | | X |
| 87* | | | | | X |
| 88 | | | | | X |
| 89 | | | | | X |
| 90* | | | | | X |
| 91 | | | | | X |
| 92 | | | | | X |
| 93 | | | | | X |
| 94* | | | | X | |
| 95 | | | | X | |
| 96 | | | X | | |
| 97* | | | X | | |
| 98 | | X | | | |
| 99 | | | | X | |
| 100 | | | | X | |
| 101 | | | X | | |
| 102 | | | X | | |
| 103* | | X | | | |
| 104 | | | | | |




# CIRCULAR FEATURES OF THE TUSAYAN RANGE DISTRICT

**Kaibab National Forest — Coconino County, Arizona**

Scale: 1 inch = 1 mile

Plate 3

September, 1992